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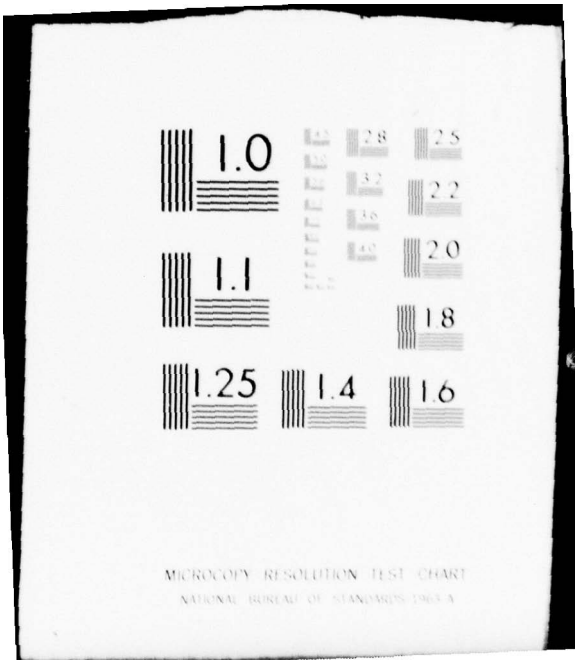
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Edward L. Ginzton Laboratory

OF THE

W. W. HANSEN LABORATORIES OF PHYSICS

STANFORD UNIVERSITY · STANFORD, CALIFORNIA 94305

11

INDEX OF REPORTS

1977 – 1978

Index of all Edward L. Ginzton Laboratory Reports
Prepared from January 1977 – September 1978
with Abstracts
Plus a List of Publications

G.L. Report No. 2900

December 1978

Contract No. N00014-75-C-0632

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TABLE OF CONTENTS

PREFACE

This index lists all Ginzton Laboratory reports for the period January 1977 through September 1978. There were 217 reports written and distributed during this time, G.L. numbers 2651 to 2869. Fourteen other indices of Ginzton Laboratory (formerly Microwave Laboratory) reports have been published: the first one for all reports from the beginning through M.L. No. 1000 (dated January 1963), a second one for the year 1963 (dated January 1964), another index for the year 1964 (dated January 1965), a fourth one for the year 1965 (dated January 1966), a fifth one for the year 1966 (dated January 1967), a sixth one for the year 1967 (dated January 1968), a seventh for the year 1968 (dated February 1969), an eighth for the year 1969 (dated April 1970), a ninth one for the years 1970 and 1971, compiled and distributed in 1972, a tenth one for the year 1972 (dated February 1973), an eleventh one for the year 1973 (dated March 1974), a twelfth one for the year 1974 (dated February 1975), a thirteenth for the year 1975 (dated March 1976), and a fourteenth for the year 1976 (dated March 1977).

This volume contains four sections, as follows:

I. A list of Ginzton Laboratory reports issued during this period which includes additional information regarding its publication, presentation at a conference, etc. The asterisk by the report number indicates that the abstract for that report is reproduced in Section III.

II. A list of Ginzton Laboratory papers which were published during this period, but which were originally submitted prior to January 1977;

III. A list of abstracts of papers written as technical reports or for publication (abstracts of contract status reports are not included); and

IV. An author index for the above three sections.

The reports listed here are generally labeled as one of three types: Technical Reports, Internal Memoranda and Preprints, or Status Reports (Semiannuals, Quarterly, Annuals).

(a) Technical Reports

Technical reports are those which document the results or conclusions of research investigation, specific problems, or complete tasks.

Technical reports generally describe work which is of more significance or of more lasting importance than Internal Memorandum type reports. Technical reports do not include managerial information, are usually bound with soft covers, and are not issued at any specific times. Final reports for a given contract, which summarize all the work done under that contract, are sometimes called technical reports.

The abstracts of the technical reports written during the noted period, namely January 1, 1977 – September 30, 1978, are reproduced in Section III.

(b) Internal Memoranda and Preprints

These reports usually describe work of limited time value, are often less comprehensive than technical reports and are usually prepared for journal publications. In some cases, papers not distributed in preprint internal memoranda form are later issued as Reprints.

Internal Memoranda and Preprints are not given wide distribution as they are usually intended for local use. However, copies, if available, may be sent on request.

(c) Status Reports

These are reports issued on some schedule in accordance with contract assignments. They may be prepared on any medium, and may or may not have covers. They generally vary in length, and describe the work done on the various projects sponsored under a given contract.

(d) Dissertations (Special Research Reports)

Dissertations may be issued as either Technical Reports or as Internal Memoranda, depending on the requirements of the contract or

grant which sponsored the research. No separate list of dissertations is included. They may be identified through the author index or by scanning through Section I.

This index also identifies the contract or grant which supported each report.

AVAILABILITY

Information about reports listed herein may be obtained by writing to:

Reports Office
Edward L. Ginzton Laboratory
W.W. Hansen Laboratories of Physics
Stanford University
Stanford, California 94305

Ginzton Laboratory reports numbered up to and through 2300 are only available in the following forms: 16 mm microfilm, 4 x 6 inch microfiche or xerox reprints. Further information regarding cost and source is available upon request.

Many Ginzton Laboratory reports are also available to qualified requestors (agencies of the Department of Defense, their contractors, or other government agencies) through

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314

Other persons and organizations should apply to

Clearinghouse for Federal Scientific and
Technical Information (CFSTI)
Sills Building
5285 Port Royal Road
Springfield, Virginia 22151

Reports which are also Ph.D. dissertations (or Special Research Reports) may be purchased on microfilm from University Microfilms, Ann Arbor, Michigan.

Individuals or organizations may be placed on a distribution list for one or more Ginzton Laboratory contracts and/or grants. Each agency has different regulations governing the distribution of reports; information will be sent on request.

I. LIST OF GINZTON LABORATORY REPORTS

January 1, 1977 – September 30, 1978

G.L. No.	Report	Contract
2651*	A. L. Schawlow, "Lasers, Light, and Matter," Preprint (January 1977). Also: Published in Journal of the Optical Society of America, Vol. 67, No. 2, 140-148 (February 1977).	NSF PHY74-14786 and N00014-75-C-0841
2652	Staff, "Generation of Coherent VUV and Soft X-Rays," Quarterly Management Report No. 6 for the period 1 October 1976 - 31 December 1976 (January 1977).	N00014-75-C-1175
2653	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for December 1976 (January 1977).	EPRI RP609-1
2654	Staff, "Optical Resonator and Beam Studies," Progress and Final Reports covering the period 15 June 1975 through 14 September 1976 (January 1977).	ERDA LASL E(29-2)-3605
2655	Staff, "Generation of Coherent VUV and Soft X-Rays," Semiannual Report No. 3, for the period 1 July - 31 December 1976 (January 1977).	N00014-75-C01175
2656	Staff, "Methods for the Detection and Characterization of Surface Flaws in Materials," Status Report covering the period 1 October - 31 January 1977 (January 1977).	RISC Grant 77-70946
2657*	A. E. Siegman, "Bragg Diffraction of a Gaussian Beam by a Crossed-Gaussian Volume Grating," Reprint from Journal of the Optical Society of America, Vol. 67, No. 4, 545-550 (April 1977).	NSF ENG74-03433

*Abstract reproduced in Section III.

G.L. No.	Report	Contract
2658	Staff, "New Techniques for Acoustic Nondestructive Testing," Semiannual Report for the period 18 July 1976 – 1 January 1977 (January 1977).	RISC 74-20773
2659*	R. B. Zubeck, C. N. King, D. F. Moore, T. W. Barbee, Jr., A. B. Hallak, J. Salem, and R. H. Hammond, "Growth Morphologies of Thick Films of Nb_3Sn Formed by Electron Beam Evaporation," Reprint from Thin Solid Films, Vol. 40, 249-261 (1977).	ERDA EY-76-S-03-0326, PA #43
2660	Staff, "Demonstration of Remote Air Pollution Measurement Capability," Quarterly Report for the period September – December 1976 (January 1977).	EPRI RP486-1
2661	Staff, "Research Studies on Techniques for High Power Visible Lasers Using Charge Exchange Collisions," Quarterly Report for the period 1 October – 31 December 1976 (January 1977).	ERDA E(04-3)-326, PA #41
2662	Staff, "Research Studies on Techniques for High Power Visible Lasers Using Charge Exchange Collisions," Final Report for the period 1 January – 31 December 1976 (March 1977).	ERDA E(04-3)-326, PA #41
2663	Staff, "Research in Acoustic Microscopy," Final Report, covering the period December 1975 – December 1976 (February 1977).	Hartford Foundation
2664	Staff, "Investigation of Laser Dynamics, Modulation and Control by Means of Intra-Cavity Time Varying Perturbation," Semiannual Status Report for the period 1 August 1976 – 31 January 1977(February 1977).	NASA NGL-05-020-103
2665*	H. Komine and R. L. Byer, "Optically Pumped Atomic Mercury Photodissociation Laser," Preprint (February 1977). Also: Published in J. Appl. Phys., Vol. 48, No. 6, 2505-2508 (June 1977).	F44620-74-C-0039

G.L. No.	Report	Contract
2666*	S. J. Brosnan, R. N. Fleming, R. L. Herbst, and R. L. Byer, "Tunable Infrared Generation by Coherent Raman Mixing," Preprint (February 1977). Also: Published in Applied Physics Letters, Vol. 30, No. 7, 330-332 (1 April 1977).	ERDA EY-76-3-04-3570
2667	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the month of January 1977 (February 1977).	EPRI RP609-1
2668*	R. Feinberg, R. E. Teets, J. Rubbmark, and A. L. Schawlow, "Ground State Relaxation Measurements by Laser-Induced Depopulation," Preprint (February 1977). Also: Published in the Journal of Chemical Physics, Vol. 66, No. 10, 4330-4333 (15 May 1977).	NSF PHY74-14786
2669*	W. A. Harrison, "The Physics of Solid State Chemistry," Preprint (March 1977). Also: Reprint from the Proceedings of the German Physical Society, Münster, Germany, (Advances in Solid State Physics), Vol. XVII, 135-155 (1977).	NSF DMR73-02351
2670*	R. L. Herbst, H. Komine, and R. L. Byer, "A 200 mJ Unstable Resonator Nd:YAG Oscillator," Preprint (February 1977). Also: Published in Optics Communications, Vol. 21, No. 1, 5-7 (April 1977).	DAAG 29-74-C-0033
2671	R. J. Sokel, "The Normalization of Eigenfunctions of the Sturm-Liouville Problem," Preprint (February 1977). Also: Published in the American Journal of Physics, Vol. 45, No. 7, 676-677 (July 1977).	NSF DMR73-02351

G.L. No.	Report	Contract
2672	Staff, "Picosecond Optical Measurements Using Ultrashort Light Pulses," Final Scientific Report for the period 1 May 1974 – 31 October 1976 (March 1977).	NSF ENG74-03433
2673*	R. L. Byer and E. R. Murray, "Remote Monitoring with Laser Sources," Internal Memorandum (March 1977).	SRI 13851
2674*	D. F. Moore and M. R. Beasley, "Tunneling Observations of Delayed Flux Entry and Surface Barriers in Nb_3Sn," Preprint (March 1977). Also: Published in Applied Physics Letters, Vo. 30, No. 9, 494-496 (1 May 1977).	NSF DMR76-00726
2675	Staff, "Acoustically Scanned Optical Imaging Devices," Semiannual Report for the period 1 July – 31 December 1976 (January 1977).	N00014-76-C-0129
2676	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the month of February 1977 (February 1977).	EPRI RP609-1
2677*	D. E. Prober, M. R. Beasley, and R. E. Schwall, "Fluctuation-Induced Diamagnetism and Dimensionality in Superconducting Layered Compounds: $TaS_2(pyridine)_{1/2}$ and $NbSe_2$," Preprint, (March 1977). Also: Published in Physical Review B, Vol. 15, No. 11, 5245-5261 (1 June 1977).	NSF DMR75-04368 and DMR76-00726 (CMR)
2678	Staff, "Innovative Measurement Technology for the Semiconductor Device Industry – "The Acoustic Microscope – A New Instrument for Viewing Integrated Circuits," Quarterly Report for the period 1 January – 31 March 1977 (March 1977).	NBS 5-35899

G.L. No.	Report	Contract
2679*	W. A. Harrison, "Elementary Theory of Heterojunctions," Reprint from Journal of Vacuum Science Technology, Vol. 14, No. 4, 1016-1021 (July/August 1977).	NSF DMR73-02351
2680*	T. M. Waugh and G. S. Kino, "Real Time Imaging with Shear Waves and Surface Waves," Preprint (March 1977). Presented at the Acoustical Imaging and Holography 7th International Conference 30 August - 1 September 1976. Also: Reprint from the Proceedings of the above-noted conference, Acoustical Holography, Vol. 7 (Plenum Publishing Corp., 1977), pp. 103-115.	RISC RI74-20773
2681*	G. Kino, W. Leung, H. Shaw, D. Winslow, and L. Zitelli, "Differential Phase Contrast Imaging in the Electronically Focused Acoustic System," Preprint (March 1977). Presented at the Acoustical Imaging and Holography 7th International Conference 30 August - 1 Sept. 1976. Also: Reprint from the Proceedings of the above-noted conference, Acoustical Holography, Vol. 7 (Plenum Publishing Corp., 1977), pp. 523-535.	EPRI RP609-1
2682	J. Souquet, G. S. Kino, and T. Waugh, "Chirp Focused Transmitter Theory," Preprint (March 1977). Presented at the Acoustical Imaging and Holography 7th International Conference 30 August through 1 September 1976. Also: Reprint from the Proceedings of the above-noted conference, Acoustical Holography, Vol. 7 (Plenum Publishing Corporation, 1977), pp. 475-493.	NSF ENG75-18681 and RISC RI74-20773
2683	Annual Index of Reports for 1976 (March 1977).	------

G.L. No.	Report	Contract
2684	Staff, "Coherent Anti-Stokes Raman Spectroscopy," Final Report (March 1977).	N00014-75-C-0894
2685	Staff, "Generation of Coherent VUV and Soft X-Rays," Quarterly Management Report for the period 1 January through 31 March 1977 (April 1977).	N00014-75-C-1175
2686	Staff, "Laser Physics and Laser Techniques," Final Technical Report for the period 1 January – 31 December 1976 (April 1977).	F44620-76-C-0070
2687	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the month of March 1977 (April 1977).	EPRI RP609-1
2688	C. F. Quate, "Scanning Acoustic Microscope," Internal Memorandum (April 1977). Presented at the Acoustic Microscopy Symposium-Workshop, Indianapolis, 14-18 February, 1977.	NSF APR75-07317
2689	C. F. Quate, "Recount of Program on Acoustic Microscopy at Stanford," Internal Memorandum (April 1977). Presented at the Acoustic Microscopy Symposium-Workshop, Indianapolis, 14-18 February 1977.	N00014-75-C-0632 and NBS5-35899
2690*	R. Teets, J. Eckstein, and T. W. Hänsch, "Coherent Two-Photon Excitation by Multiphase Light Pulses," Preprint (April 1977). Also: Published in Physical Review Letters, Vol. 38, No. 14, 760-764 (4 April 1977).	NSF PHY74-14786 and N00014-75-C-0841
2691	R. Kompfner and C. F. Quate, "Acoustic Radiation and Its Use in Microscopy," Preprint (April 1977). Also: Published in Physics in Technology (November 1977).	NSF APR75-07317 and NBS5-35899

G.L. No.	Report	Contract
2692	Staff, "Tunable Optical Sources," Semiannual Report for the period 1 October 1976 – 31 March 1977 (April 1977).	DAAG29-74-C-0033
2693	Staff, "A 1.4 – 18 μm Tunable Coherent Spectrometer," Quarterly Report (April 1977).	ERDA LASL EY-76-S-04-3570
2694	Staff, "Two Photon Laser Studies," Final Report for the period June 1975 – January 1977 (May 1977).	LASL NP5-11296-1
2695*	C. DeSilets, J. Fraser, and G. S. Kino, "The Design of Efficient Broadband Piezoelectric Transducers," Preprint (May 1977). To be published in IEEE Trans. on Sonics and Ultrasonics.	NSF ENG75-18681 and N00014-75-C-0632
2696*	A. G. Evans, G. S. Kino, B. T. Khuri-Yakub, and B. R. Tittmann, "Failure Prediction in Structural Ceramics," Preprint (May 1977).	RISC 76-63282 and RISC 74-20773
2697	Staff, "Improved Resolution in the Acoustic Microscope," Final Report (April 1977).	NSF ENG75-02028
2698	Staff, "Acoustic Imaging Systems," Final Report (March 1977).	N00123-75-C-1385
2699	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the month of April 1977 (May 1977).	EPRI RP609-1
2700	T. W. Hänsch, "High-Resolution Spectroscopy of Atoms and Molecules," Reprint from Physics Today, (May 1977).	NSF PHY74-14786
2701	Staff, "Scanning Acoustic Microscope," Annual Report covering the period 1 April 1976 – 31 March 1977 (April 1977).	NSF APR75-07317
2702*	N. J. Moll, "Acoustic Detection of Thermal Radiation," Internal Memorandum and Special Research Report (June 1977).	DAHC04-74-G-0093

G. L. No.	Report	Contract
2703	Staff, "Study of Nonlinear Acoustics for the Purpose of Processing 'Sophisticated Signals'," Final Report for the period 1 January 1974 – 28 February 1977 (June 1977).	DAHC04-74-G-0093
2704	W. A. Harrison, "Abstract: Surface Reconstruction," Reprint from the Journal of Vacuum Science Technology, Vol. 14, No. 4, 883 (July/August 1977).	NSF DMR73-02351 and DAAK02-74-C-0069
2705	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report for the period 10 March – 9 June 1977 (June 1977).	F19628-77-C-0072
2706	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the month of May 1977 (June 1977).	EPRI RP609-1
2707*	C. E. Wieman, "Polarization Spectroscopy and the Measurement of the Lamb Shift in the Ground State of Hydrogen," Internal Memorandum and Special Research Report (July 1977).	NSF PHY77-09687
2708*	B. A. Auld and Bing-Hui Yeh, "Piezoelectric Shear Surface Wave Grating Resonators," Preprint (May 1977). To appear in Proceedings of the 31st Annual Symposium on Frequency Control.	N00014-75-C-0632
2709*	G. S. Kino, "Acoustic Wave Measurements of Semiconductor Parameters," Preprint (June 1977). Invited Paper to the International Symposium on Microwave Diagnostics and Semiconductors, 13-15 July, Porvoo, Finland.	NSF ENG75-18681 and N00014-75-C-0632
2710*	H. Komine and R. L. Byer, "Optically Pumped Hg_2 Studies," Reprint from the Journal of Chemical Physics, Vol. 67, No. 6, 2536-2546 (15 September 1977).	F49620-77-C-0092 and ERDA EY-76-S-04-3570
2711	Staff, "Methods for the Detection and Characterization of Surface Flaws in Materials," Final Report for the period 1 October 1976 – 30 June 1977 (June 1977).	RISC 77-70946

G.L. No.	Report	Contract
2712*	Max Artusy and A. E. Siegman, "Saturable Absorber Overlap of Iodine 127 with the Optically Pumped 546-nm Mercury Laser," Reprint from Applied Physics Letters, Vol. 31, No. 5, 333-334 (1 September 1977).	F49620-77-C-0092
2713	Staff, "Innovative Measurement Technology for the Semiconductor Device Industry – 'The Acoustic Microscope – A New Instrument for Viewing Integrated Circuits," Quarterly Report for the period 1 April – 30 June 1977 (June 1977).	NBS5-35899
2714	Staff, "New Techniques for Acoustic Nondestructive Testing," Third Annual Report for the period 4 June 1976 – 3 June 1977 (June 1977).	RISC 74-20773
2715*	P. Borden and G. S. Kino, "Input Correlation with the ASW Storage Correlator," Preprint (July 1977). Also: Published in Electronics Letters, Vol. 13, No. 16, 470-471 (4 August 1977).	N00014-76-C-0129
2716	Staff, "Acoustically Scanned Optical Imaging Devices," Semiannual Report for the period 1 January – 30 June 1977 (July 1977).	N00014-76-C-0129
2717	Staff, "Generation of Coherent VUV and Soft X-Rays," Quarterly Management Report for the period 1 April – 30 June 1977 (July 1977).	N00014-75-C-1175
2718	Staff, "Generation of Coherent VUV and Soft X-Rays," Semiannual Report for the period 1 January – 30 June 1977(July 1977).	N00014-75-C-1175
2719	G. S. Kino and B. A. Auld, "Reciprocity Theories for Flaw Analysis," Preprint (July 1977). Presented at the Annual Review of Progress in Quantitative NDE, 12 - 17 June 1977.	N00014-76-C-0129

G.L. No.	Report	Contract
2720	G.S. Kino and B.T. Khuri-Yakub, "High Frequency Ultrasonics," Preprint (June 1977). Presented at the Annual Review of Progress in Quantitative NDE" in Ithaca, New York June 12-17, 1977.	RISC 74-20773
2721	G.S. Kino, D. Corl, and T. Waugh, "Acoustic Imaging Systems," Preprint (June 1977). Presented at the Annual Review of Progress in Quantitative NDE" in Ithaca, New York, June 12-17, 1977.	RISC 74-20773
2722	D. Barnett, G. Herrmann, J. Hunter, G. Johnson, G.S. Kino, W. Leung, A. Selfridge, J. Shaw, C. Steele, and T. Waugh, "Stress Measurements with Ultrasound," Preprint (June 1977). Presented at the Annual Review of Progress in Quantitative NDE" in Ithaca, New York, June 12-17, 1977.	EPRI RP-609-1 and NSF DMK-76-00726
2723	Staff, "Perturbation and Variational Studies of Acoustic Waveguide Problems," Annual Report (July 1977).	NSF ENG74-00334
2724	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Monthly Report for the Month of June 1977 (July 1977).	EPRI RP609-1
2725*	P. Borden and G.S. Kino, "The Charging Process in the Acoustic Surface Wave P-N Diode Storage Correlator," Preprint (July 1977). Also: Published in Applied Physics Letters, Vol. 31, No. 8, 488-490 (15 October 1977).	N00014-76-C-0129 and NSF ENG75-18681
2726*	S.E. Harris, "Spontaneous Anti-Stokes Scattering as a High Resolution and Picosecond Time Scale VUV Light Source," Preprint (August 1977). Also" Published in Applied Physics Letters, Vol. 31, No. 8, 498-500 (15 October 1977).	N00014-75-C-1175

G.L. No.	Report	Contract
2727*	S.E. Harris and J.C. White, "Numerical Analysis of Laser Induced Inelastic Collisions," Preprint (August 1977). Also: Published in IEEE Journal of Quantum Electronics, Vol. QE-13, No. 12, 972-978 (December 1977).	F19628-77-C-0072 and N00014-75-C-0576
2728	Staff, "Tunable Optical Sources," Final Report for the period 1 July 1974 – 30 June 1977 (July 1977).	DAAG29-74-C-0033
2729*	J.E.M. Goldsmith and I.N. Knyazev, "A Simple Compact High-Repetition-Rate Hydrogen VUV Laser for Scientific Applications," Preprint (August 1977). Also: Published in the Journal of Applied Physics, Vol. 48, No. 12, 4912-4921 (December 1977).	NSF PHY77-09687
2730	Staff, "Processing of Optical Images with Optically Controlled Acoustic Transducers," Interim Technical Report for the period 15 June 1976 – 14 June 1977 (August 1977).	AFOSR76-3059
2731*	H.K. Wickramasinghe and C. Yeack, "Nonlinear Imaging of an Edge in the Scanning Acoustic Microscope," Reprint from Journal of Applied Physics, Vol. 48, No. 12, 4951-4954 (December 1977).	NSF ENG75-02030
2732*	R.E. Teets, F.V. Kowalski, W.T. Hill, N. Carlson, and T.W. Hänsch, "Laser Polarization Spectroscopy," Preprint (August 1977). Presented at the Laser Spectroscopy Conference. Also: Published in SPIE Vol. 113 - Advances in Laser Spectroscopy, pp. 80-87 (1977).	NSF PHY77-09687
2733	S. Kim, R.E. Howard, and M.R. Beasley, "Thermal Stability of Superconductors with Large Surface Barriers to Flux Entry: Superconducting Power Line Conductors," Preprint (July 1977).	ERDA E(04-3)-326, P.A.43

G.L. No.	Report	Contract
2734	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 22nd Monthly Report for the month of July 1977 (August 1977).	EPRI RP609-1
2735*	A. Atalar, C.F. Quate, and H.K. Wickramasinghe, "Phase Imaging in Reflection with the Acoustic Microscope," Preprint (September 1977). Also: Published in Applied Physics Letters, Vo. 31, No. 12, 791-793 (15 December 1977).	NBS5-35899 and N00014-75-C-0632
2736	Staff, "Optically Pumped Mercury Lasers for Ring Laser Gyroscope Applications," Preliminary Final Technical Report covering the period 1 June 1976 – 31 August 1977 (October 1977).	AFOSR76-3043
2737*	B.T. Khuri-Yakub and G.S. Kino, "A New Technique for Excitation of Surface and Shear Acoustic Waves on Nonpiezoelectric Materials," Preprint (September 1977). Also: Published in Applied Physics Letters, Vol. 32, No. 9, 513-514 (1 May 1978).	RISC 76-63282 and NSF ENG75-18681
2738	Staff, "Investigation of Laser Dynamics, Modulation and Control by Means of Intra-Cavity Time Varying Perturbation," Semi-annual Status Report No. 27 covering the period 1 February 1977 – 31 August 1977 (September 1977).	NASA NGL05-020-103
2739	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 23rd Monthly Report for the month of August 1977 (September 1977).	EPRI RP609-1
2740	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report for the period 10 June – 9 September 1977 (September 1977).	F19628-77-C-0072
2741*	H.C. Tuan and G.S. Kino, "A Monolithic Zinc-Oxide-on-Silicon P-N Diode Storage Correlator," Reprint from Applied Physics Letters, Vol. 31, No. 10, 641-643 (15 November 1977).	N00014-76-C-0129

G.L. No.	Report	Contract
2742*	G.S. Kino, "The Application of Reciprocity Theory to Scattering of Acoustic Waves by Flaws," Preprint (September 1977). Also: Published in the Journal of Applied Physics, Vol. 49, No. 6, 3190-3199 (June 1978).	RISC 74-20773
2743*	T.W. Hänsch, "Measuring the Wavelength of Light with a Self-Calibrating Grating," Preprint (September 1977). Also: Published in Optics Letters, Vol. 1, 191-193 (December 1977).	NSF PHY77-09687
2744*	S. Kim, R.E. Howard, and M.R. Beasley, "Thermal Stability of Superconductors with Large Surface Barriers to Flux Entry: Superconducting Power Line Conductors," Preprint (July 1977). Also: Published in the Journal of Applied Physics, Vol. 49, No. 2, 730-735 (February 1978).	ERDA E(04-3)-326, P.A.43
2745*	R. Trutna and A.E. Siegman, "Laser Cavity Dumping Using an Antiresonant Ring," Reprint from IEEE Journal of Quantum Electronics, Vol. QE-13, No. 12, 955-962 (December 1977).	ERDA EY-76-S-03-0326, PA No. 56
2746	Staff, "Pseudopotential Methods in Physics," Annual Report for the period September 1976 – September 1977 (October 1977).	NSF DMR73-02351
2747	Staff, "Generation of Coherent VUV and Soft X-Rays," Quarterly Management Report No. 9 covering the period 1 July - 30 September 1977 (October 1977).	N00014-75-C-1175
2748	Staff, "Microwave Acoustic and Bulk Device Technique Studies," Final Technical Report, December 1977.	F30602-74-C-0038
2749	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 24th Monthly Report for September 1977 (October 1977).	EPRI RP609-1

G.L. No.	Report	Contract
2750	Staff, " Innovative Measurement Technology for the Semiconductor Industry — 'The Acoustic Microscope — A New Instrument for Viewing Integrated Circuits'", Quarterly Report for the period 1 July - 30 September 1977 (September 1977).	NBS 5-35899
2751	Staff, "Coherent Anti-Stokes Raman Spectroscopy," Addendum to Final Report (October 1977).	N00014-75-C-0894
2752*	H. C. Tuan and G.S. Kino, "Large Time Bandwidth Product Correlation and Holographic Storage with an ASW Storage Correlator," Preprint (October 1977). Also: Published in Electronics Letters, Vol. 13, No. 24, pp. 709-710 (24 November 1977).	N00014-76-C-0129
2753*	H. Komine, "Energy Storage and Two-Photon Extraction from Metastable States," Final Report and Special Research Report (November 1977).	F44620-74-C-0039
2754	Staff, "Widely Tunable Coherent Spectrometer and Applications to Active Spectroscopy," Final Report, covering the period 1 May 1975 - 30 September 1977 (October 1977).	ERDA EY-76-S-04-3570
2755	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 25th Monthly Report for the month of October 1977 (November 1977).	EPRI RP609-1
2756*	D. Corl, "A CTD Adaptive Inverse Filter," Preprint (November 1977). Also: Published in Electronics Letters, Vol. 14, No. 3, pp. 60-62 (2 February 1978).	RISC 74-20773
2757	Staff, "Research Studies on Techniques for High Power Lasers using Metastable Energy Storage," Quarterly Report for the period 1 August - 31 October 1977 (December 1977).	ERDA EY-76-S-03-0326, P.A. 60

G.L. No.	Report	Contract
2758	Staff, "Tunable Lasers and Coherent Light Techniques for High Resolution Ultraviolet Spectroscopy," Technical Report No. 6 for the period 1 January - 31 December 1977 (December 1977).	N00014-75-C-0841
2759*	A. Atalar, "An Angular Spectrum Approach to Contrast in Reflection Acoustic Microscopy," Preprint (December 1977). Also: Published in the Journal of Applied Physics, Vol. 49, No. 10, 5130-5139 (October 1978).	NBS 5-35899 and AFOSR 77-3455
2760	Staff, "Properties of New Superconducting Materials," Final Report (December 1977).	AFOSR-73-2435
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2762*	R. H. Hammond, "Synthesis and Physical Properties of Superconducting Compound Films Formed by the Electron-Beam Codeposition of the Elements," Reprint from the Journal of Vacuum Science and Technology, Vol. 15, No. 2, 382-385 (March/April 1978).	ERDA E(04-3)-326, PA 43 and F49620-78-C-0009
2763	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report No. 3 for the period 10 September - 9 December 1977 (December 1977).	F19628-77-C-0072
2764	Staff, "Instrumentation for Acoustical Discrimination of Biological Cells," Final Scientific Report for the period 15 April 1973 - 30 June 1977 (December 1977).	NSF APR72-03583
2765	Staff, "Innovative Measurement Technology for the Semiconductor Device Industry — 'The Acoustic Microscope — A New Instrument for Viewing Integrated Circuits'," Quarterly Report for the period 1 October - 31 December 1977 (December 1977).	NBS 5-35899

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2766*	L.J. Zych and J.F. Young, "Limitation of 3547 Å to 1182 Å Conversion Efficiency in Xe," Preprint (October 1977). Also: Published in IEEE Journal of Quantum Electronics, Vol. QE-14, No. 3, 147-149 (March 1978).	N00014-75-C-1175 and NASA NGL-05-020-103
2767*	S.J. Poon and T.H. Geballe, "The Eliashberg Function $\alpha^2F(\omega)$ and Phonon Spectrum $F(\omega)$. I. A Simple Model for Amorphous s-p Superconductor," Preprint (January 1978). Also: Published in Physical Review B, Volume 18, No. 1, 233-244 (1 July 1978).	F49620-78-C-0009
2768	Staff, "New Techniques for Acoustic Nondestructive Testing," Semiannual Report for period July 1 1977 – January 1, 1978.	RISC 74-20773
2769	Staff, "Generation of Coherent VUV and Soft X-Rays," Quarterly Management Report No. 10 for the period 10 October 1977 – 31 December 1977 (January 1978).	N00014-75-C-1175
2770	Staff, "Generation of Coherent VUV and Soft X-Rays," Semiannual Report No. 5 for the period 1 July – 31 December 1977 (January 1978).	N00014-75-C-1175
2771	NUMBER VOIDED	
2772	Staff, "Tunable Optical Sources," Semiannual Report No. 1 for the period 1 September – 31 December 1977 (January 1978).	DAAG29-77-G-0221
2773	Staff, "Acoustic Microscopy at Cryogenic Temperatures," Status Report for the period 1 July 1977 – 1 January 1978 (January 1978).	N00014-77-C-0412
2774*	P.M. Grant, "Signal Processors Based on Combined Charge Coupled Devices and Surface Acoustic Wave Devices," Preprint (January 1978). Presented at the 1978 IEEE Int'l. Symposium on Circuits and Systems (ISCAS) May 17-19, 1978.	N00014-75-C-0632

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2775	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 26th Monthly Report for the period November-December 1977 (January 1978).	EPRI RP609-1
2776*	J. Fraser, G.S. Kino, and J. Birnholz, "Cepstral Signal Processing for Tissue Signature Analysis," Preprint (January 1978). Presented at the Second International Symposium on Ultrasonic Tissue Characterization, June 13-15, 1977.	NSF ENG75-18681
2777*	B.T. Khuri-Yakub, A.G. Evans, G.S. Kino, and B.R. Tittmann, "Acoustic Surface Wave Scattering: The Detection of Surface Cracks in Ceramics," Internal Memorandum (February 1978).	RISC 76-63282
2778*	L.J. Zych, J. Lukasik, J.F. Young, and S.E. Harris, "Laser-Induced Two-Photon Blackbody Radiation in the Vacuum Ultraviolet," Preprint (February 1978). Also: Published in Physical Review Letters, Vol. 40, No. 23, 1493-1496 (5 June 1978).	N00014-75-C-1175 and NASA NGL 05-020-103
2779*	W.A. Harrison, "Theory of Polar Semiconductor Surfaces," Preprint (February 1978).	NSF DMR77-21384 and DAAK 02-74-C-0069
2780*	T.W. Hänsch,"New Methods of Laser Spectroscopy," Reprint from IPC Science and Technology Press Ltd., pp. 108-113 (1978).	NSF PHY74-14786 and N00014-75-C-0841
2781*	J. Fraser, B.T. Khuri-Yakub, and G.S. Kino, "The Design of Efficient Broadband Wedge Transducers," Preprint (February 1978). Also: Published in Applied Physics Letters, Vol. 32, No. 11, 698-700 (1 June 1978).	NSF ENG75-18681
2782*	A.L. Schawlow, "Laser Interactions with Materials," Reprint from IPC Science and Technology Press Ltd., pp. 263-266 (1978).	NSF PHY77-09687

G.L. No.	Report	Contract
2783	Staff, "Research Studies on Techniques for High Power Lasers Using Metastable Energy Storage," Quarterly Report covering the period 1 November 1977 – 31 January 1978 (February 1978).	ERDA EY-76-S-03-0326, P.A. 60
2784	Staff, "Acoustically Scanned Optical Imaging Devices," Semiannual Report No. 5 covering the period 1 July – 31 December 1977 (February 1978).	N00014-76-C-0129
2785	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 27th Monthly Report covering the month of January 1978 (February 1978).	EPRI RP609-1
2786*	W.R. Green and R.W. Falcone, "Inversion of the Resonance Line of Sr^+ Produced by Optically Pumping Sr Atoms," Preprint (February 1978). Also: Published in Optics Letters, Vol. 2, 115-116 (May 1978).	NASA NGL 05-020-103 and N00014-75-C-0576
2787	Staff, "Research Studies on Techniques for Generation of Ultraviolet and Vacuum Ultraviolet Radiation," Final Report (February 1978).	LLL 8532009
2788*	D.F. Moore, "Electron Tunneling into the A15 Superconductors: Nb_3Sn, V_3Si, and Nb_3Ge," Internal Memorandum and Special Research Report (February 1978).	N00014-77-C-0439
2789	Staff, "A High Field Superconducting Magnet Facility," Final Report for the period 1 June 1976 – 30 November 1977 (February 1978).	NSF DMR76-03013
2790*	V. Jipson and C.F. Quate, "Acoustic Microscopy at Optical Wavelengths," Preprint (February 1978). Also: Published in Applied Physics Letters, Vol. 32, No. 12, 789-791 (15 June 1978).	AFOSR-77-3455
2791	Staff, "Optically Pumped Mercury Lasers for Ring Laser Gyroscope Applications," Final Technical Report for the period 1 June 1976 – 30 April 1978 (April 1978).	AFOSR-76-3043

G.L. No.	Report	Contract
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2793*	W.P. Leung, "Acoustic Imaging with a 100-Element Electronically Scanned and Focused Phased Array," Technical Report and Special Research Report (March 1978).	EPRI RP609-1
2794*	F.V. Kowalski, W.T. Hill, and A.L. Schawlow, "Saturated-Interference Spectroscopy," Preprint (March 1978). Also: Published in Optics Letters, Vol. 2, 112-114 (May 1978).	NSF PHY77-09687
2795*	J.C. White, "Inversion of the Na Resonance Line by Selective Photodissociation of NaI," Preprint (March 1978). Also: Published in Applied Physics Letters, Vol. 33, No. 4, 325-327 (15 August 1978).	F19628-77-C-0072 and ERDA EY-76-S-03-326, P.A. 60
2796	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 28th Monthly Report for February 1978 (March 1978).	EPRI RP609-1
2797	Staff, "Investigation of Laser Dynamics, Modulation and Control by Means of Intra-Cavity Time Varying Perturbation," Semiannual Status Report No. 28 for the period 1 September 1977 – 28 February 1978 (February 1978).	NASA NGL-05-020-103
2798*	J.N. Eckstein, A.I. Ferguson, and T.W. Hänsch, "High Resolution Two-Photon Spectroscopy with Picosecond Light Pulses," Preprint (March 1978). Also: Published in Physical Review Letters, Vol. 40, No. 13, 847-850 (27 March 1978).	NSF PHY77-09687 and
2799	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report No. 4 covering the period 10 December 1977 – 9 March 1978 (March 1978).	F19628-77-C-0072

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2800*	Peter Borden, "The Storage Correlator: Theory and Signal Processing Applications," Technical Report and Special Research Report (April 1978).	N00014-76-C-0129
2801	Staff, "Research Studies on Radiative Collision Lasers," Interim Technical Report covering the period 10 March 1977 – 9 March 1978 (April 1978).	F19628-77-C-0072
2802	Staff, "Innovative Measurement Technology for the Semiconductor Device Industry – 'The Acoustic Microscope – A New Instrument for Viewing Integrated Circuits'," Quarterly Report covering the period 1 January – 31 March 1978 (March 1978).	NBS 5-35899
2803	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 29th Monthly Report for March 1978 (April 1978).	EPRI RP609-1
2804*	R.A. Baumgartner and R.L. Byer, "Remote SO_2 Measurements at 4 μm with a Continuously Tunable Source," Preprint (April 1978). Also: Published in Optics Letters Vol. 2, 163-165 (June 1978).	SRI 14307
2805	Staff, "Laser Physics and Laser Techniques," Annual Technical Report for the year 1 January – 31 December 1977 (April 1978).	F49620-77-C-0092
2806*	G.S. Kino, J.B. Hunter, G.C. Johnson, A.R. Selfridge, D.M. Barnett, G. Herrmann, and C.R. Steele, "Acoustoelastic Imaging of Stress Fields," Preprint (April 1978). Presented at the First International Symposium on Ultrasonic Materials Characterization, Gaithersburg, Maryland (June 1978).	EPRI RP609-1
2807	Staff, "Acoustically Scanned Optical Imaging Devices," Management Report covering the period 1 January – 31 March 1978 (April 1978).	N00014-76-C-0129

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2808*	B. A. Auld, "General Electromechanical Reciprocity Relations Applied to the Calculation of Elastic Wave Scattering Coefficients," Preprint (April 1978). To appear in Wave Motion.	RISC 77-70946
2809	Staff, "Research Studies on Techniques for High Power Lasers Using Metastable Energy Storage," Quarterly Report for the period 1 February – 30 April 1978 (May 1978).	ERDA EY-76-S-03-0326, P.A. 60
2810*	S. E. Harris and J. F. Young, "Rapid Laser Induced Energy Transfer in Atomic Systems," Reprinted from Radiation Energy Conversion in Space, vol. 61, of Progress in Astronautics and Aeronautics (1978).	F19628-77-C-0072 and NASA NGL-05-020-103
2811	Staff, "Studies of Techniques for Generation of Vacuum Ultraviolet and Soft X-Ray Laser Radiation," Final Report covering the period 1 October 1976 – 30 April 1978 (May 1978).	N00014-75-C-0576
2812	Staff, "Tunable Lasers and Coherent Light Techniques for High Resolution Ultraviolet Spectroscopy," Final Technical Report covering the period 1 April 1975 – 31 March 1978 (May 1978).	N00014-75-C-0841
2813*	P.D. Corl, G.S. Kino, C.S. DeSilets, and P.M. Grant, "A Digital Synthetic Focus Acoustic Imaging System," Preprint (May 1978). Presented at the Acoustical Imaging 8th Internation Conference at Key Biscayne, Florida, May 29 - June 2, 1978.	RISC RI74-20773
2814*	V. Domarkas, B.T. Khuri-Yakub, and G.S. Kino, "Length and Depth Resonances of Surface Cracks and Their Use for Crack Size Estimation," Preprint (May 1978). Also: Published in Applied Physics Letters, Vol. 33, No. 7, 557-559 (1 October 1978).	N00014-78-C-0283

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2815*	G.S. Kino, T.M. Waugh, P.D. Corl, C.S. DeSilets, and P.M. Grant, "Acoustic Imaging Techniques for Nondestructive Testing," Preprint (May 1978). Presented at the First International Symposium on Ultrasonic Materials Characterization at Gaithersburg, Maryland in June 1978.	RISC RI74-20773
2816	Staff, "Research on New Approaches to Optical Systems for Inertial Rotation Sensing," Interim Report for the period 1 June 1976 – 30 September 1977.	AFOSR-76-3070
2817	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Thirtieth Monthly Report for April 1978 (May 1978).	EPRI RP609-1
2818	J.C. White and G.A. Zdasiuk, "Branching Ratios for $T\ell Br$ Photodissociation with 2660 Å Radiation," Preprint (June 1978). Also: Published in the Journal of Chemical Physics, Vol. 69, No. 5, 2256-2257 (1 September 1978).	F19628-77-C-0072 and ERDA EY-76-S-03-0326, PA 60
2819*	S.E. Harris, J. Lukasik, J.F. Young, and L.J. Zych, "Anti-Stokes Emission as a VUV and Soft X-Ray Source," Preprint (June 1978). Also: Published in Picosecond Phenomena, eds. C.V. Shank, E.P. Ippen, and S.L. Shapiro, New York: Springer-Verlag, 1978.	NASA NGL-05-020-103, N00014-75-C-1175, and N00014-75-C-0632
2820	Staff, "Innovative Measurement Technology for the Semiconductor Device Industry – 'The Acoustic Microscope – A New Instrument for Viewing Integrated Circuits," Quarterly Report for the period April – June 1978 (June 1978).	NBS 5-35899
2821*	R.E. Teets, "Polarization Labeling Spectroscopy of Molecules," Internal Memorandum and Special Research Report, July 1978.	NSF PHY77-09687

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2822*	M.T. Resch, B.T. Khuri-Yakub, G.S. Kino, and J.S. Shyne, "Stress Intensity Factor Measurement of Surface Cracks," Preprint (June 1978). Presented at the First International Symposium on Ultrasonic Materials Characterization, Gaithersburg, Maryland, June 1978.	NSF DMK-76-00726
2823*	G.S. Kino, J.B. Hunter, G.C. Johnson, A.R. Selfridge, D.M. Barnett, G. Herrmann, and C.R. Steele, "Measurement of Stress Fields in Metals," Preprint (June 1978).	EPRI RP609-1 and NSF DMK-76-00726
2824*	G.S. Kino, "Acoustic Imaging for Non-destructive Evaluation," Preprint (June 1978).	RISC RI74-20773 and EPRI RP609-1
2825*	Y. Murakami, B.T. Khuri-Yakub, G.S. Kino, J.M. Richardson, and A.G. Evans, "The Application of Adaptive Filtering to Defect Characterization," Preprint (June 1978). Presented at the First International Symposium on Ultrasonic Materials Characterization, Gaithersburg, Maryland, June 1978.	RISC RI74-20773
2826*	W. A. Harrison, "Fifty Years of Metals Theory," Preprint (June 1978). To appear in Felix Bloch and Twentieth Century Physics, published by Rice Studies, Rice University.	NSF DMR 77-21384
2827	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Thirty-First Monthly Report for May 1978 (June 1978).	EPRI RP609-1
2828*	Y. Murakami, B.T. Khuri-Yakub, G.S. Kino, J.M. Richardson, and A.G. Evans, "An Application of Wiener Filtering to Non-destructive Evaluation," Preprint (June 1978). Also: Published in Applied Physics Letters, Vol. 33, No. 8, 685-687 (15 October 1978).	RISC RI74-20773
2829	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report for the period 10 March – 9 June 1978 (June 1978).	F19628-77-C-0072

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2830*	A.I. Ferguson, J.N. Eckstein, and T.W. Hänsch, "A Subpicosecond Dye Laser Directly Pumped by a Mode-Locker Argon Laser," Preprint (June 1978). Also: Published in Journal of Applied Physics, Vol. 49, No. 11, 5389 (November 1978).	N00014-75-C-0841
2831*	J.N. Eckstein, "High Resolution Spectroscopy Using Multiple Coherent Interactions," Internal Memorandum and Special Research Report (August 1978).	N00014-75-C-0841
2832*	F.V. Kowalski, "New Methods in Laser Spectroscopy," Internal Memorandum and Special Research Report (August 1978).	NSF PHY77-09687
2833*	C.S. DeSilets, "Transducer Arrays Suitable for Acoustic Imaging," Internal Memorandum and Special Research Report (June 1978).	N00014-75-C-0632 and RISC RI74-20773
2834*	B.A. Auld, G. Elston, and D.K. Winslow, "A Novel Microwave Ferromagnetic Resonance Probe for Eddy Current Detection of Surface Flaws in Metals," Preprint (June 1978). To appear in the Proceedings of the 8th European Microwave Conference, Paris, September 1978.	NSF DMR76-00726
2835*	P.M. Grant and G.S. Kino, "Adaptive Filter Based on SAW Monolithic Storage Correlator," Preprint (July 1978). Also: Published in Electronics Letters, Vol. 14, No. 17, pp. 562-564 (17 August 1978).	N00014-76-C-0129
2836*	R.A. Baumgartner and R.L. Byer, "Continuously Tunable IR Lidar with Applications to Remote Measurements of SO_2 and CH_4," Preprint (July 1978). To appear in Applied Optics, Vol. 17 (15 November 1978).	SRI-14307

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2837*	R.W. Falcone, J.R. Willison, J.F. Young, and S.E. Harris, "Measurement of the He $1s2s\,^1S_0$ Isotopic Shift Using a Tunable VUV Anti-Stokes Light Source," Preprint (July 1978). To appear in Optics Letters, Vol. 3, November 1978.	N00014-78-C-0403
2838*	G.S. Kino, P.M. Grant, P.D. Corl, and C.S. DeSilets, "Digital Synthetic Aperture Acoustic Imaging for NDE," Preprint (July 1978). Presented at the ARPA/AFML Review of Progress in Quantitative NDE at LaJolla, California (July 1978).	RISC RI74-20773
2839	B.A. Auld, "Theory of Ferromagnetic Resonance Probes for Surface Cracks in Metals," Preprint (July 1978).	NSF DMR76-00726
2840	Staff, "Generation of Coherent VUV and Soft X-Rays," Final Report for the period 1 July 1974 – 30 June 1978 (July 1978).	N00014-75-C-1175
2841	Staff, "Optical Picosecond Viewing of Biological Material," Final Scientific Report for the period 1 September 1976 – 28 February 1978 (June 1978).	NSF ENG76-11230
2842	Staff, "Tunable Optical Sources," Semi-annual Report No. 2 for the period 1 January – 30 June 1978 (July 1978).	DAAG29-77-G-0221
2843*	H.K. Wickramasinghe, "Contrast and Imaging Performance in the Scanning Acoustic Microscope," Preprint (July 1978). To appear in Journal of Applied Physics (November 1978).	NSF ENG75-02030 and AFOSR-77-3455
2844*	G.S. Kino, "Acoustoelasticity," Preprint (July 1978). An Invited Paper for the ASME Conference, San Francisco, December 1978.	EPRI RP609-1 and NSF DMK76-00726
2845*	F.V. Kowalski, R.E. Teets, W. Demtröder, and A.L. Schawlow, "An Improved Wavemeter for CW Lasers," Preprint (July 1978). To appear in the Journal of the Optical society of America.	NSF PHY77-09687

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2846*	R.E. Howard, D.A. Rudman, and M.R. Beasley, "Josephson Properties of Nb_3Sn/Pb Tunnel Junctions," Preprint (July 1978). Also: Published in Applied Physics Letters, Vol. 33, #7, 671-673 (1 October 1978).	N00014-77-C-0439
2847	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Thirty-Second Monthly Report for 1 June - 31 July 1978 (August 1978).	EPRI RP609-1
2848	Staff, "Acoustic Wave Phenomenon for Signal Processing," Final Report period ending 31 March 1978 (August 1978).	NSF ENG75-18681
2849	Staff, "Research Studies on Techniques for High Power Lasers Using Metastable Energy Storage," Final Report for the period 1 August 1977 — 31 July 1978 (August 1978).	ERDA EY-76-S-03-0326, PA 60
2850*	H.K. Wickramasinghe, R.C. Bray, V. Jipson, C.F. Quate, and J.R. Salcedo, "Photo-acoustics on a Microscopic Scale," Preprint (August 1978). To appear in the Applied Physics Letters November 15, 1978 issue.	AFOSR-77-3455
2851*	M.T. Resch, B.T. Khuri-Yakub, G.S. Kino, and J.C. Shyne, "The Acoustic Measurement of Stress Intensity Factors," Preprint (August 1978). Accepted for publication in Applied Physics Letters.	NSF DMK76-00726
2852	Staff, "Ultrashort Pulses at CO_2 Wavelengths," Final Report covering the period 1 April 1977 — 31 March 1978 (April 1978).	ERDA EY-76-S-03-0326 PA 56
2853*	J.C. White, G.A. Zdasiuk, J.F. Young, and S.E. Harris, "Observation of Radiative Collisional Fluorescence," Preprint (August 1978).	F19628-77-C-0072
2854	Staff, "Investigation of Laser Dynamics, Modulation and Control by Means of Intra-Cavity Time Varying Perturbation," Semiannual Report for the period 1 March — 31 August 1978 (September 1978).	NASA NGL-05-020-103

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2855*	S.J. Poon and J. Durand, "Magnetic Clusters Description of Spin Glasses in Amorphous La-Gd-Au Alloys," Preprint (August 1978). To appear in Physical Review B.	F49620-78-C-0009
2856	A. L. Schawlow, "Laser Spectroscopy of Atoms and Molecules," Preprint (August 1978). To appear in Science.	NSF PHY77-09687
2857*	R.L. Byer and W.R. Trutna, "16-μm Generation by CO_2-Pumped Rotational Raman Scattering in H_2," Reprint from Optics Letters, Vol. 3, 144-146 (October 1978).	Exxon Grant-in-Aid and F49620-77-C-0092
2858	Staff, "Electronic Structure of Transition Metal Compounds," Final Report for the period 1 May 1973 – 30 September 1978 (September 1978).	DAAG29-73-C-0024 and DAAG29-77-C-0022
2859*	B.T. Khuri-Yakub, G.S. Kino, J.C. Shyne, M.T. Resch, and V. Domarkas, "Surface Crack Characterization: Geometry and Stress Intensity Factor Measurements," Preprint (September 1978). To appear in Proc. ARPA/AFML Review of Progress in Quantitative NDE.	NSF DMK-76-00726 and N00014-78-C-0283
2860	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Thirty-third Monthly Report for August 1978 (September 1978).	EPRI RP609-1
2861	S.J. Poon, "The Range of Indirect Exchange Interaction in an Amorphous Magnet," Preprint (September 1978). To be published in Physics Letters A.	F49620-78-C-0009
2862*	P.D. Corl, P.M. Grant, and G.S. Kino, "A Digital Synthetic Focus Acoustic Imaging System for NDE," Preprint (September 1978). To appear in the Proceedings of the 1978 Ultrasonics Symposium.	RISC R174-20773
2863*	E.W. Weber and J.E.M. Goldsmith, "Double-Quantum Saturation Spectroscopy in Hydrogen: Measurement of the $3P_{3/2}$-$3D_{3/2}$ Lamb Shift," Preprint (September 1978). Also: Published in Physical Review Letters, Vol. 41, #14, 940-944 (2 October 1978).	NSF PHY77-09687

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2864	Staff, "Research Studies on Radiative Collision Lasers," Quarterly Report for the period 10 June – 9 September 1978 (September 1978).	F19628-77-C-0072
2865	Staff, "Acoustic Microscopy at Cryogenic Temperatures," Annual Summary Report for the period 1 July 1977 – 30 June 1978 (September 1978).	N00014-77-C-0412
2866*	C.S. DeSilets, A.R. Selfridge, and G.S. Kino, "Highly Efficient Transducer Arrays Useful in Nondestructive Testing Applications," Preprint (September 1978). To appear in the 1978 Ultrasonics Symposium Proceedings.	RISC R174-20773 and N00014-75-C-0632
2867*	J.E. Bowers, B.T. Khuri-Yakub, G.S. Kino, and K-H Yu, "Design and Applications of High Efficiency Wideband SAW Edge Bonded Transducers," Preprint (September 1978). To appear in the 1978 Ultrasonics Symposium Proceedings.	N00014-76-C-0129 and NSF ENG77-28528
2868	S. Early and T. H. Geballe, "Silicon-on-Sapphire Thermometer for Low-Temperature Small Sample Calorimetry," Preprint (September 1978).	F49620-78-C-0009
2869*	G. Herrmann and G.S. Kino, "Ultrasonic Measurements of Inhomogeneous Stress Fields," Preprint (September 1978). To appear in the Proceedings of the ARPA/AFML Conference on NDE, La Jolla, California.	EPRI RP609-1 and NSF DMJ76-00726

II. PAPERS PUBLISHED IN 1977-1978

FROM MANUSCRIPTS SUBMITTED PRIOR TO 1977

G.L. No.	Report	Contract
2479	H. Gautier and G.S. Kino, "A Detailed Theory of the Acoustic Wave Semiconductor Convolver," Preprint (September 1975 – Revised May 1976). Published in IEEE Trans. on Sonics and Ultrasonics, Vol. SU-24, #1, 23-33 (January 1977).	N00014-67-A-0112-0084 and NSF GK-24635
2536	W.L. Bond, C.M. Fortunko, S.L. Quilici, H.J. Shaw, and J. Souquet, "Surface Acoustic Wave Probing with Spaced Interdigital Transducers," Preprint (February 1976). Published in Review of Scientific Instruments, Vol. 48, #6, 682 (June 1977).	N00014-75-C-0632
2570	L. Bui, H.J. Shaw, and L.T. Zitelli, "Study of Acoustic Wave Resonance in Piezoelectric PVF_2 Film," Preprint (May 1976). Published in IEEE Trans. on Sonics and Ultrasonics, Vol. SU-24, #5, 331-336 (September 1977).	N00014-75-C-0632
2612	R.E. Howard, M.R. Beasley, T.H. Geballe, C.N. King, R.H. Hammond, R.H. Norton, J.R. Salem, and R.B. Zubeck, "Electrical Properties of Multilayered Nb_3Sn Superconducting Power Line Conductors," Preprint (September 1976). Published in IEEE Trans. on Magnetics, Vol. MAG-13, #1, 138-143 (January 1977).	ERDA E(04-3)-326 P.A. 43
2615	R.W. Falcone, W.R. Green, J.C. White, J.F. Young, and S.E. Harris, "Observation of Laser Induced Inelastic Collisions," Preprint (September 1976). Published in Physical Review A, Vol. 15, #3, 1333-1335 (March 1977).	N00014-75-C-0576 and ERDA E(04-3)-326 P.A. 41

G.L. No.	Report	Contract
2640	R.T. Hawkins, W.T. Hill, F.V. Kowalski, A.L. Schawlow, and S. Svanberg, "Stark Effect Study of Excited States in Sodium Using Two-Photon Spectroscopy," Preprint (November 1976). Published in Physical Review A, Vol. 15, #3, 967-974 (March 1977).	NSF PHY74-14786
2650	C.F. Quate, "Acoustic Microscopy," Preprint (December 1976). Published in Trends in Biochemical Sciences, Vol. 2, N127-129 (June 1977).	NSF APR75-07317

III. ABSTRACTS OF REPORTS

January 1, 1977 – September 1978

G.L. No.

2651 A. L. Schawlow, "Lasers, Light, and Matter."

The nature of light can be known and understood only through its interactions with matter. A few of the new ways that lasers can extend our knowledge of these interactions are discussed. They include methods for eliminating Doppler broadening from thermal motions in gases, such as saturated absorption and polarization spectroscopy. A convenient digital wavemeter for measuring wavelengths of tunable lasers is described. Complicated absorption spectra can be simplified by using a laser to modify the population or polarization of the chosen lower level.

2657 A. E. Siegman, "Bragg Diffraction of a Gaussian Beam by a Crossed-Gaussian Volume Grating."

An analytic expression is derived for the Bragg diffraction of a Gaussian probe beam by a weak crossed-Gaussian volume grating. The volume grating itself is assumed to have been created by two other Gaussian excitation beams intersecting in a nonlinear medium.

2659 R. B. Zubeck, C. N. King, D. F. Moore, T. W. Barbee, Jr., A. B. Hallak, J. Salem, and R. H. Hammond, "Growth Morphologies of Thick Films of Nb_3Sn Formed by Electron Beam Evaporation."

Thick films of Nb_3Sn (in the ordered A-15 phase) have been synthesized by codeposition of the elements niobium and tin from separate electron-beam-heated sources onto heated rotating Hastelloy B tube substrates. Using a fixed deposition rate (approximately 60 Å s^{-1} effective at the tube surface), single-layer samples 2.8 μm and 7 μm thick were prepared at substrate temperatures ranging between 830 K and 1020K. The samples were examined using scanning electron microscopy, electron microprobe analysis and X-ray diffraction. The transition from porous columnar to dense columnar growth was observed. Column diameters increased monotonically with substrate temperature. For substrate temperatures between 650°C and 700°C a very shiny deposit was formed with a <211> growth orientation. In layered structures formed by sequential deposition of Nb_3Sn (about 420 Å $layer^{-1}$) and yttrium (about Å $layer^{-1}$) the columnar growth observed in single-layer thick films appeared to be disrupted. Using the technique of fine layering, thick films of Nb_3Sn with acceptable 50 Hz loss and outstanding critical current density have been prepared for superconducting power transmission line applications.

2665 H. Komine and R. L. Byer, "Optically Pumped Atomic Mercury Photodissociation Laser."

We have generated superfluorescent laser action in atomic mercury at 0.546 μm and 0.365 μm by optically pumping Hg_2 with 0.266 μm radiation.

G.L. No.

2665 (continued)

Superfluorescent thresholds were observed at less than 6 mJ/cm^2 input energy density in a 5-nsec pulse for an atomic mercury density greater than 3×10^{18} cm^{-3}.

2666 S. J. Brosnan, R. N. Fleming, R. L. Herbst, and R. L. Byer, "Tunable Infrared Generation by Coherent Raman Mixing in H_2."

We have generated continuously tunable infrared output between 3.5 and 13 μm by coherent Raman mixing in H_2 gas at 20 atm using a Nd:YAG laser-pumped $LiNbO_3$ parametric oscillator as the input source. The coherent Raman mixing method offers significant advantages over stimulated Raman scattering for frequency conversion.

2668 R. Feinberg, R. E. Teets, J. Rubbmark, and A. L. Schawlow, "Ground State Relaxation Measurements by Laser-Induced Depopulation."

We have directly measured the repopulation rate for an individual rotational level in the electronic ground state of a homonuclear molecule. A pulsed dye laser was used to depopulate (v",J") level of Na_2 by pumping a transition of the form (v',J') ← (v",J") in the $B^1\Pi_u - X^1\Sigma_g^+$ blue-green band system. The (v",J") state was repopulated by collisions with other sodium species and with an argon buffer gas. The transmission of a second, delayed, pulsed dye laser was monitored, serving as a probe of the (v",J") state's population at various delay times. The argon pressure was varied and the procedure repeated. The Na_2-argon collision cross section may also be determined by this method.

2669 W. A. Harrison, "The Physics of Solid State Chemistry."

Between the extremes of a chemist's empirical observation of chemical trends and a physicist's a priori calculations of energy bands lies the possibility of simple approximate model calculations of solid-state properties. Those which relate the bonding properties to the underlying electronic structure of specific systems are a part of solid-state chemistry. Such theories are less accurate than empirical interpolation where sufficient data exist, but provides intuitive understanding and allow studies beyond the range of existing experiments. They are also less precise than a priori calculations, which however only move with difficulty beyond calculations of the energy bands themselves.

In simple metals the basis for such theory was provided by pseudopotential perturbation theory. In covalent and ionic solids LCAO theory seems more successful. We discuss how a single set of atomic and interatomic LCAO parameters can provide elementary predictions of almost the entire range or properties of covalent and ionic solids. We see in particular how to estimate electronic energy levels in heterogeneous systems and at surfaces. We also explore questions related to effective charges and to angular rigidity, with emphasis on ionic solids. The concepts of ion softening and the chemical grip are useful in describing the corresponding numerical calculations.

G.L. No.

2670 R. L. Herbst, H. Komine, and R. L. Byer, "A 200 mJ Unstable Resonator Nd:YAG Oscillator."

We have designed and operated a positive branch 6.3 mm diameter rod Nd:YAG unstable resonator oscillator with a 12 nsec, 200 mJ Q-switched output at 10 Hz repetition rate. When followed by a single 9 mm diameter Nd:YAG amplifier output energies up to 750 mJ were obtained with a divergence less than 0.5 mrad.

2673 R. L. Byer and E. R. Murray, "Remote Monitoring with Laser Sources."

Single-ended depth resolved absorption measurements of pollutants in the atmosphere are now possible with high energy tunable laser sources. Present system performance capabilities include detection sensitivities to approximately 10 ppb with depth resolutions of less than 100 m for ranges exceeding 3 km. Single-ended long path absorption measurements out to ranges greater than 12 km are now possible. In this chapter the measurement methods are briefly reviewed followed by detailed discussion of two operating remote monitoring systems.

2674 D. F. Moore and M. R. Beasley, "Tunneling Observations of Delayed Flux Entry and Surface Barriers in Nb_3Sn."

The results of a study of flux entry into Nb_3Sn using tunneling are described. It is found that barriers to flux entry as large as 170 mT, well in excess of the lower critical field H_{c1}, are possible in bulk Nb_3Sn. Important details of the magnetic field dependence of the surface barrier are also reported.

2677 D. E. Prober, M. R. Beasley, and R. E. Schwall, "Fluctuation-Induced Diamagnetism and Dimensionality in Superconducting Layered Compounds: $TaS_2(pyridine)_{1/2}$ and $NbSe_2$."

The results of an investigation of fluctuation-induced diamagnetism in superconducting layered compounds are presented. These results are used to establish the dimensionality of the superconducting fluctuation effects near T_c. Compounds studied include the intercalated compound $TaS_2(pyridine)_{1/2}$, and unintercalated $NbSe_2$ and $TaS_{1.6}Se_{0.4}$. The susceptibility above T_c, and magnetization in the superconducting state, were measured in fields up to 327 Oe with a superconducting quantum-interference magnetometer suitable for a broad range of sensitive magnetic measurements. The operation and performance of this magnetometer are described. Results for $TaS_2(pyridine)_{1/2}$ indicate that in low fields and near T_c, the fluctuation effects are three-dimensional in nature, where this is established via a comparison with previous results for an isotropic alloy, Pb-5% Tl. This conclusion as to the dimensionality of the superconducting effects is in accord with the qualitative predictions of the Lawrence-Doniach theory for weakly-coupled superconducting layers. Data for $NbSe_2$ have a number of complicating features, and firm conclusions regarding this material could not be drawn.

G.L. No.

2679 W. A. Harrison, "Elementary Theory of Heterojunctions."

An LCAO theory of heterojunction band-edge discontinuities is formulated and tested for approximate self-consistency. It leads to a table of valence-band maxima for all tetrahedral semiconductors; discontinuities can be obtained from the table directly by subtraction. The discrepancies with the current scattered data do not appear significantly larger than the uncertainty in those data, a few tenths of electron volts. A pseudopotential theory of such discontinuities is also formulated, based upon self-consistent atomic pseudopotentials. This leads to valence-band maxima reasonably consistent with the LCAO theory, except for junctions between materials of significantly different bond length. It also suggests that the Frensley-Kroemer scheme does produce self-consistency for systems of matching lattice constant, but produces incorrect trends with mismatch in lattice constant. The goal in any case is taken to be a table of valence-band maxima. LCAO values seem a better standard than photoelectric thresholds, though a comparison of the two indicates them to be roughly consistent for treating junctions if both sides are homopolar or if both sides are polar.

2680 T. M. Waugh and G. S. Kino, "Real Time Imaging with Shear Waves and Surface Waves."

A chirp focused phased array B-scan imaging system has been employed to obtain cross sectional images in metals. Good quality images with a field of view of 5 - 20 cm × 5 cm of arrays of holes have been observed using shear waves, Rayleigh waves, Lamb waves, and flexural waves in thin sheets of metal. With 2.5 MHz Rayleigh waves, we have detected and located surface flaws as small as 250 μm deep and 1000 μm diameter.

2681 G. Kino, W. Leung, H. Shaw, D. Winslow, and L. Zitelli, "Differential Phase Contrast Imaging in the Electronically Focused Acoustic System."

Phase contrast imaging, which has been used in optical imaging for years, has recently been introduced into acoustic imaging, in systems using mechanical scanning. In this paper, a phase contrast imaging system is introduced which employs electronic scanning and focusing. Differential phase contrast imaging is used, which compares the phases at adjacent points on the object which are separated by a constant distance along the scan line. The advantage of differential phase contrast imaging, as compared to fixed reference phase contrast imaging, is that the reference and signal beams travel almost identical paths, suppressing the effects of vibration, temperature, and other external influences. The present system consists of an acoustic receiver using a 100-element PZT array, which has two identical main beams separated slightly in space, focused at the same distance and scanned simultaneously. The relative phases between the two beams can be varied, and for "dark field" imaging they are set 180° out of phase. The output of the receiver then reproduces either the phase distribution across the object, or its spatial derivative. Two-dimensional

G.L. No.

2681 (*continued*)

differential phase contrast images are obtained by adding a mechanical frame scan. The peripheral sensitivity of this system is presently 12° phase difference, and the ultimate objective is a few degrees.

2690 R. Teets, J. Eckstein, and T. W. Hänsch, "Coherent Two-Photon Excitation by Multiphase Light Pulses."

We have studied Doppler-free two-photon excitation of atoms with a train of phase coherent standing wave light pulses, originating from the same laser pulse. Quantum interference effects produce narrow spectral fringes which have a physical origin similar to that of Ramsey fringes. Linewidths much less than the Fourier-transform limit of an individual light pulse have been observed for the sodium 3S-5S transition, and a dramatic enhancement of the resonant signal is possible.

2695 C. DeSilets, J. Fraser, and G. S. Kino, "The Design of Efficient Broadband Piezoelectric Transducers."

A design method for acoustic thin disc transducers with high efficiency, broad bandwidth, and good impulse response is presented. This method is based on the use of quarter-wave matching layers between the piezoelectric material and the acoustic load. As is made evident using the transmission line model of Krimholtz, Leedom, and Matthaei, the finite thickness of the piezoelectric material must be taken into account in the matching layer design. Criteria for optimum broadband transducer designs with a given piezoelectric material are developed which show the importance of a high electromechanical coupling coefficient. A method for obtaining Gaussian shaped passbands, necessary for optimum impulse response, is also shown. Several transducers have been built to illustrate this design approach with excellent agreement between theory and experiment. One such transducer has 3.2 dB round trip insertion loss and one octave bandwidth.

2696 A. G. Evans, G. S. Kino, B. T. Khuri-Yakub, and B. R. Tittmann, "Failure Prediction in Structural Ceramics."

The failure prediction requirements and the pertinent accept/reject criteria for structural ceramics are derived, and the available failure prediction techniques are examine, vis-a-vis the failure prediction relations, in order to highlight the capabilities and limitations of each technique. The need for additional techniques is thereby demonstrated. The capabilities of the ultrasonic technique are extensively evaluated, in order to determine its ability to satisfy the deficiencies in the existing failure prediction repertoire. The prospects are shown to be very encouraging, but the results of several key studies must be awaited before defining the ultimate role of ultrasonic failure prediction techniques.

G.L. No.

2702 N. J. Moll, "Acoustic Detection of Thermal Radiation."

A new type of uncooled thermal imaging device is described. The device consists of an array of semiconductor bolometers scanned by a piezoelectric acoustic delay line. The scanning is done by charging the surface of each bolometer by means of a strong rf pulse on the delay line, and observing the rate of decay of the surface charge; this rate is strongly temperature dependent. The detailed theory of operation of the device is developed, including the processes of surface charging and discharging, acoustic attenuation as a function of the semiconductor's surface charge, thermal design problems, and noise processes. The fundamental principle of operation and the practicability of meeting some thermal design requirements are verified experimentally using silicon bolometers on a lithium niobate delay line.

The significant theoretical findings are as follows: the charging process takes place through a nonlinearity in the surface majority carrier concentration vs applied field. Because of the nonlinearity, a large ac field, such as is produced by a 3 watt per centimeter acoustic pulse on lithium niobate, causes a substantial increase in the surface carrier concentration. The excess carriers are then trapped in surface states. The discharge process should be controlled by minority carrier generation in the space charge region, at least for silicon. A new theory of acoustic attenuation by a depleted semiconductor is presented. It indicates that the main source of attenuation is the release of majority carriers by charged surface states. The predictions of this theory are in considerably better agreement with experiment than those of previous theory, which did not account for the effect of surface states. The noise performance of the device should be limited by background quantum noise and by statistical variations in surface state occupation. The low frequency detectivity of the device should be 2×10^{10} centimeter per watt in a 1 Hz bandwidth, but would have a cutoff frequency less than 0.1 Hz for a typical device. By making 0.25 micron thick bolometers it should be possible to raise this frequency to 5 Hz.

The experimental findings show that the basic description of the device's operation is exact. In particular, discharge of the surface state charge is by minority carrier generation, with the expected temperature sensitivity. Also, it is shown that bolometers can be built with power sensitivity approaching the theoretical limit, by supporting the bolometers with small photoresist spacers.

The totality of the theoretical and experimental results comprise a foundation for the construction of an imaging device of the type described. Such a device could outperform existing uncooled thermal imaging devices over a practical range of frequencies.

G.L. No.

2707 C. E. Wieman, "Polarization Spectroscopy and the Measurement of the Lamb Shift in the Ground State of Hydrogen."

The Lamb shifts of the ground state of hydrogen and deuterium have been measured using nonlinear laser spectroscopy. The measured values are 8161.0 ± 29 MHz for hydrogen and 8183.1 ± 29 MHz for deuterium, which are in excellent agreement with the theoretical results. The Lyman-α isotope shift between hydrogen and deuterium has also been measured, giving a value of 67099.3 ± 6.3 MHz. This gives the first experimental confirmation of the relativistic nuclear recoil contribution to hydrogenic energy levels.

The Lamb shift was obtained by comparing four times the energy of the Balmer-β (n=2 to n=4) transition with the 1S-2S energy difference. A very high resolution spectrum of the Balmer-β line was obtained using a single frequency cw dye laser and a new form of Doppler-free spectroscopy, polarization spectroscopy. The 1S-2S Doppler-free transition was simultaneously observed by sending part of the cw beam through a high power pulsed amplifier system. The amplified pulses were then frequency doubled and the doubled photons used to excite the 1S-2S transition in a hydrogen cell. The excitation was monitored by observing the 1215 Å photons which are emitted as the 2S state decays. The Lyman-α isotope shift was obtained by comparing the 1S-2S transition frequencies for hydrogen and deuterium.

The technique of polarization spectroscopy was developed specifically for this experiment, but has applications in many other areas as well. The basic concept is that one uses two counterpropagating laser beams in a gas sample. The first beam is circularly polarized to create an optical anisotropy, which can be very sensitively detected by observing its effect on the linear polarization of the second beam. Because the beams are counterpropagating the interactions between them are Doppler-free. Polarization spectroscopy can be 100 to 1000 times more sensitive than comparable techniques such as saturated absorption spectroscopy.

2708 B. A. Auld and Bing-Hui Yeh, "Piezoelectric Shear Surface Wave Grating Resonators."

This paper describes a new type of surface acoustic wave grating resonator in which the particle displacement of the surface wave is parallel to the surface. By contrast, the now well-known SAW (Rayleigh wave) grating resonator has its particle displacement in the saggital plane.

In the SAW resonator the function of the grating structure, which consists of either grooves or metal strips, is to provide two highly reflecting Rayleigh wave mirrors, between which a standing wave is excited by means of an interdigital transducer. The basic function of the grating in the horizontal shear (SH) type of surface wave resonator considered here is quite different. An SH surface wave cannot exist on a homogeneous (unlayered) substrate in the absence of some periodic variation, such as a grating, along the surface. That is to say, the surface wave in this case is a vibrational mode of the grating itself. On the other hand, the grating is now not required to realize a highly reflecting mirror, because the SH motion reflects

G.L. No.

2708 (continued)

without spurious mode coupling at a traction-free boundary placed in any symmetry plane of the structure. For this reason this new type of resonator promises a substantial advantage in miniaturization compared with the conventional SAW resonator.

SH surface wave resonators on PZT-8, Y-cut, X-propagating $LiNbO_3$ and ST quartz have been fabricated and tested. Excitation was by means of an interdigital structure deposited on top of the grating teeth, and the dimensions were chosen to give a resonance in the region of 1 to 2 MHz. The groove depth was in the range of 0.01", and it was found that the diamond saw fabrication technique used did not provide adequate precision. Consequently the quality factors realized were low (< 3000), and use of relatively shallower etched grooves at higher frequencies is clearly called for.

Since a sufficient condition for the existence of this type of surface wave is a periodicity of the conditions along the surface, another technique for trapping the wave at the surface is deposition of an array of metal strips.

2709 G. S. Kino, "Acoustic Wave Measurements of Semiconductor Parameters."

Various types of acoustic surface wave techniques for measuring the parameters of a semiconductur are discussed in this paper. These include techniques to measure mobility, carrier density, surface state density, and trapping time in surface states.

2710 H. Komine and R. L. Byer, "Optically Pumped Hg_2 Studies."

The continuous emission bands of molecular mercury at 0.335 and 0.485 μm are excited in a pure mercury vapor by direct optical pumping of the weakly bound ground state molecules with a 5 nsec pulse of intense 0.266 μm radiation in order to study the radiative and collisional properties of the excited molecules at densities between 10^{14} and 10^{15} cm^{-3}. Fluorescence time history of both bands are empirically analyzed in terms of dynamics governing the excited molecules. The analysis includes a density-dependent nonexponential decay caused by bimolecular excimer quenching with a measured rate constant of $k \approx 2 \pm 1 \times 10^{-10}$ cm^3 sec^{-1} $molecule^{-1}$. Because of interest in the mercury system as a potential laser medium, estimates of gain coefficients are derived from fluorescent power measurements. However, transmission measurements of the excited medium at 0.325 and 0.4416 μm show significant net loss due to excited state absorption with an estimated absorption cross section on the order of 10^{-17} cm^2 at 0.325 μm. Energy storage limitations implied by the bimolecular excimer quenching are also examined.

G.L. No.

2712 Max Artusy and A. E. Siegman, "Saturable Absorber Overlap of Iodine 127 with the Optically Pumped 546-nm Mercury Laser."

A single isolated saturated-absorption feature in $^{127}I_2$ using the optically pumped 546.1-nm Hg laser has been observed with low (~6 MHz) resolution. The $^3S_1 \rightarrow {}^3P_2$ Hg laser transition can be centered exactly on this feature by varying the N_2 buffer gas pressure using the measured pressure tuning rate of -9.4 MHz/Torr. This may provide an attractive laser system for absolute wavelength stabilization.

2715 P. Borden and G. S. Kino, "Input Correlation with the ASW Storage Correlator."

By correlating during readin, we correlate signals of much greater length than could be stored within the device, thereby obtaining a large improvement in TB product.

2725 P. Borden and G.S. Kino, "The Charging Process in the Acoustic Surface Wave P-N Diode Storage Correlator."

We demonstrate analytically and experimentally that the acoustic surface wave p-n diode storage correlator may be charged either very quickly or very slowly, depending on the input signal levels, and independent of the diode storage time. Thus, the same long storage time device is usable for both high-speed and slow (such as integrating) applications.

2726 S.E. Harris, "Spontaneous Anti-Stokes Scattering as a High Resolution and Picosecond Time Scale VUV Light Source."

A VUV and soft x-ray light source based on spontaneous anti-Stokes scattering from atomic population stored in a metastable level is proposed. It is shown that the source has a maximum brightness equal to that of a blackbody at a Boltzmann temperature characteristic of the population of the metastable level. This maximum brightness is attained as the media approaches two-photon opacity. The source should have high resolution, may be of picosecond time scale, and on a pulsed basis should be brighter than other laboratory scale VUV light sources.

2727 S.E. Harris and J.C. White, "Numerical Analysis of Laser Induced Inelastic Collisions."

The paper studies the dynamics of (dipole-dipole) laser induced collision processes. Coupled equations are numerically integrated, first over time, and then over impact parameter. Transition probability and collision cross section are given as a function of the detuning from the $R = \infty$ frequency of the separated atoms, and of the incident laser power density. Numerical results are compared with approximate formulae for collision cross section at line center and in the wing.

G.L. No.

2729 J.E.M. Goldsmith and I.N. Knyazev, "A Simple, Compact, High-Repetition-Rate Hydrogen VUV Laser for Scientific Applications."

The operation of a simple, compact, high-repetition-rate VUV hydrogen laser is described in detail. The laser uses a Blumlein-type transverse discharge system with a very narrow profiled discharge channel and a low inductance, nitrogen pressurized, triggered spark gap switch. The laser produces 20 μJ pulses of approximately 1/2 nsec duration at 1600 Å (corresponding to a peak power of about 40 kW). The dependence of the pulse energy on the operating parameters of the laser is reported. Laser action in nitrogen, neon, and XeF^* has also been observed.

2731 H.K. Wickramasinghe and Celia Yeack, "Nonlinear Imaging of an Edge in the Scanning Acoustic Microscope."

When harmonics are produced in the scanning acoustic microscope, the resultant images have a complex appearance which requires interpretation. A theoretical calculation of the distribution of harmonic radiation has been made for the case of a focused beam scanning across the edge of an object such as a Mylar sheet suspended in water. The results show that most of the harmonic signal is generated in the water, and that diffraction causes the appearance of fringes in the image. Experimental results agree with the theory.

2732 R.E. Teets, F.V. Kowalski, W.T. Hill, N. Orlson, and T.W. Hänsch, "Laser Polarization Spectroscopy."

Polarization spectroscopy makes use of the polarization dependence of the nonlinear interaction between two laser beams in a gaseous medium. The laser-induced optical anisotropy is calculated using a rate equation approach, and the effect of this anisotropy on a polarized probe beam is derived. The method is useful for Doppler-free spectroscopy, for similification of molecular spectra, and for relaxation studies. A comparison with other Doppler-free saturation spectroscopy methods shows an advantage in signal-to-noise for polarization spectroscopy. Recent high resolution experiments with hydrogen, molecular sodium, and nitrogen dioxide are presented.

2735 A. Atalar, C.F. Quate, and H.K. Wickramasinghe, "Phase Imaging in Reflection with the Acoustic Microscope."

When a polished surface of a single crystal is examined with a converging acoustic beam the reflected signal has a characteristic response that is dependent upon the elastic properties of the reflecting surface. This property can be used in the acoustic microscope to monitor the thickness of layers deposited on these surfaces and the small-scale variations of the elastic parameters in these materials.

G.L. No.

2737 B.T. Khuri-Yakub and G.S. Kino, "A New Technique for Excitation of Surface and Shear Acoustic Waves on Nonpiezoelectric Materials."

An interdigital transducer deposited on a piezoelectric substrate has been used to excite SAW on nonpiezoelectric materials by using a fluid couplant. The piezoelectric substrate is held at an angle to the nonpiezoelectric material so as to match the tangential k vectors of the surface waves. Experiments have been carried out with a $LiNbO_3$ piezoelectric substrate and a ceramic such as SiC or Si_3N_4 with a fluid couplant. At a center frequency of 100 MHz, the estimated conversion efficiency of the surface wave from the piezoelectric to the nonpiezoelectric material is -3.5 dB. The results compare favorably with a normal mode coupling theory we have developed which predicts -2.7 dB efficiency.

2741 H.C. Tuan and G.S. Kino, "A Monolithic Zinc-Oxide-on-Silicon P-N Diode Storage Correlator."

A monolithic zinc-oxide-on-silicon p-n storage correlator has been constructed. When operated both as a convolver and as a storage correlator, the electronic efficiency obtained with this device is comparable to that of the present $LiNbO_3$ airgap devices. This device has the potential of having very large dynamic range because of the absence of spurious bulk-wave generation, as occurs in the airgap device. Several signal-processing functions have been demonstrated with this new type of storage correlator. In one chirp correlation experiment, correlation of signals with a time-bandwidth product of 4000 has been observed.

2742 G.S. Kino, "The Application of Reciprocity Theory to Scattering of Acoustic Waves by Flaws."

The reciprocity theorem and the scattering matrix formalism of electromagnetic theory have been adapted to obtain formulas for scattering of acoustic waves from flaws. The technique has been applied, in the Born approximation, to determine scattering of the plane waves by small flaws, and with an elastostatic approximation to find the scattering from a flat elliptical crack. A third example is a treatment of the optical approximation to scattering from a curved interface between two media. In all cases results are obtained which are applicable for flaws placed either in the Fresnel region or Fraunöfer region of unfocused transducers, or near the focal point of a focused transducer. A fourth example, given in the Appendix, uses the reciprocity theory to derive the axial field of a piston transducer in contact with the surface of a solid.

2743 T.W. Hänsch, "Measuring the Wavelength of Light with a Self-Calibrating Grating."

A novel scheme for absolute wavelength measurements with a grating spectrograph is proposed. A grating with special multiple rulings is illuminated with a reference laser of known wavelength to project a ruler-like diffraction pattern of equidistant wavelength calibtation lines directly onto the unknown spectrum.

G.L. No.

2744 S. Kim, R.E. Howard, and M.R. Beasley, "Thermal Stability of Superconductors with Large Surface Barriers to Flux Entry: Superconducting Power-line Conductors."

The effect of surface barriers to flux entry on the stability of superconductors at low fields is considered theoretically in the context of the usual critical-state model. The presence of such a barrier is found to greatly reduce overall stability unless a thin normal-metal overcoat is used to stabilize the superconductor. The relevance of these results to superconducting power transmission lines is discussed.

2745 R. Trutna and A.E. Siegman, "Laser Cavity Dumping Using an Antiresonant Ring."

A New method for laser cavity dumping using an antiresonant ring laser cavity and an electrooptic phase modulator has been demonstrated on a CO_2 laser at 10.6 μm. Experimental results are summarized and the cavity and modulator design considerations for this type of cavity dumping are reviewed in this paper. Although the initial experiments were done at 10.6 μm, the antiresonant ring technique may be particularly advantageous for high-power lasers such as ruby and Nd:glass in the visible and near IR. A modified form of the antiresonant ring for accomplishing extremely fast phase switching is also proposed.

2752 H.C. Tuan and G.S. Kino, "Large Time Bandwidth Product Correlation and Holographic Storage with an ASW Storage Correlator."

High-resolution (375 Hz) spectrum analysis has been performed by correlating long signals during the read-in process. In a ZnO-on-Si storage correlator a new holographic storage technique is demonstrated to achieve chirp compression with large compression ratio ($\sim$ 8000) and improved dynamic range.

2753 H. Komine, "Energy Storage and Two-Photon Extraction from Metastable States."

This report presents experimental studies on the energy storage characteristics of excited metastable species and theoretical analysis of optical energy extraction schemes based on stimulated two-photon transitions. Metastable states of atoms and molecules have recently received attention as optical energy storage media for potential high power laser applications. The large energy capacity and long lifetime of metastable states offer attractive properties for generating high energy optical pulses for laser fusion and photochemical studies. Recent experimental results on the metastable states of molecular mercury

G.L. No.

2753 (continued)

illustrate some of the important properties of energy storage in a gaseous medium. In particular, collisional deactivation of excited metastable species by mutual two-body quenching and by molecular formation are discussed in relation to storage limitations. The measured quenching rate constant in the mercury dimmer system suggests a maximum storage density on the order of 10^{17} cm^{-3} with a lifetime of 0.1 microsecond, which corresponds to an optical energy capacity of 50 joules per liter. The optical extraction of energy stored in an inverted metastable system using stimulated two-photon transitions offers nonlinear characteristics not available in the ordinary laser amplifiers. Since the extraction efficiency is an important amplifier parameter, the growth of an optical pulse in the steady-state approximation is investigated theoretically including the saturation of the medium. Analytical expressions for the extraction efficiency of an ideal two-photon emission amplifier are derived. The feasibility of two-photon amplifier is discussed with two proposed systems in atomic mercury and atomic iodine. The semi-empirical methods of gain calculation are described for the near-resonance case and the non-resonant case. The use of spherical tensor operator algebra and the evaluation of electric dipole matrix elements in the intermediate angular momentum coupling scheme are discussed. The experimental requirements for the proposed systems based on the calculated gains indicate that the currently available pumping methods and trigger laser sources may lead to a demonstration of two-photon amplification and energy extraction.

2756 D. Corl, "A CTD Adaptive Inverse Filter."

An inverse filter, incorporating a charge-transfer-device (CTD), tapped analog delay line and digitally programmed tap weights, is reported. This computer controlled analog processor performs a zero-forcing algorithm under software control. The inverse filter (or transversal equalizer) is demonstrated with an LC resonator as the distorting medium. The results show that this processor permits partially overlapping distorted impulses to be clearly discriminated.

2759 A. Atalar, "An Angular-Spectrum Approach to Contrast in Reflection Acoustic Microscopy."

The scanning acoustic microscope in the reflection mode has proved to be a rather simple and direct means for monitoring the elastic properties of a solid surface. When smooth surfaces of crystalline material are examined in a liquid with a highly convergent sound beam they exhibit a distinct response. This characteristic response, which can be treated as a "signature", is obtained by recording the output of the microscope as the spacing between the acoustic lens and the object is varied. An angular-spectrum approach is used to derive an expression for this output in terms of the reflectance function. This function has an angular dependence determined by the bulk constants of the material itself. The expression resulting from this treatment can be used to explain the source of contrast in acoustic images.

G.L. No.

2762 R.H. Hammond, "Synthesis and Physical Properties of Superconducting Compound Films Formed by the Electron-Beam Codeposition of the Elements."

Electron-beam codeposition of the elements to form certain high critical temperature superconducting materials, in particular A-15 compounds, has proven to be very useful in research directed at understanding and improving their superconducting properties. This work has used the close control of three or more evaporant sources to reproducibly make specimens that permit studies across selected regions of composition and phase space. The effect of composition and phase, together with the temperature and rate of deposition, on the growth morphology and superconducting properties has been studied. The superconducting properties measured include the critical temperature, ac loss, critical current density, and tunnel junction characteristics. The particular compounds studied include Nb_3Sn, Nb_3Ge, and V_3Si.

2766 L.J. Zych and J.F. Young, "Limitation of 3547 Å to 1182 Å Conversion Efficiency in Xe."

We report experiments which indicate that the 3547 Å → 1182 Å conversion efficiency in Xe-Ar mixtures is limited by Kerr-induced dispersion to about 0.9%. The mixed-frequency third order nonlinearity $\chi^{(3)}(-3\omega, 3\omega, -\omega, \omega)$ significantly alters the index of refraction at 1182 Å in the presence of large power densities at 3547 Å, affecting phasematching. We suggest using a Xe-Mg-Ar mixture to reduce the effect, thus permitting increased efficiencies.

2767 S.J. Poon and T.H. Geballe, "The Eliashberg Function $\alpha^2F(\omega)$ and Phonon Spectrum $F(\omega)$. A Simple Model for an Amorphous s-p Superconductor."

A simple expression of the Eliashberg function $\alpha^2F(\omega)$ for an amorphous s-p superconductor is obtained. One finds that $\alpha^2F(\omega) = (1/\omega) \times \Sigma_q(L(\vec{q}) + N(\vec{q}))\delta(\omega - \omega_q)$ where $\vec{q}$ includes phonon branch index; $N(\vec{q})/\omega_q$ is the N-process which conserves "lattice" momentum; $L(\vec{q})/\omega_q$ replaces the U-process in the crystalline phase and it selects "lattice" momentum through the structure factor of the amorphous phase. Both $L(\vec{q})$ and $N(\vec{q})$ are evaluated using the Heine-Animalu pseudopotential form factor and experimental structure factor. A qualitative deconvolution of the phonon spectrum $F(\omega)$ from $\alpha^2F(\omega)$ for four alloys is attempted. The main findings are:

(i) Due to the non-conservation of "lattice" momentum in the conventional sense, $\alpha^2F(\omega)$ depends linearly on ω in the very low-ω region similar to Bergmann's results on disordered superconductors. The calculated first derivatives of $\alpha^2F(\omega)$ are in good agreement with tunneling data on amorphous superconductors.

G.L. No.

2767 (continued)

(ii) The deconvoluted $F(\omega)$ are in better agreement with theoretical results obtained using the Morse potential than the Lennard-Jones potential.

(iii) The Hopfield-McMillan parameter η tends to decrease in the amorphous phase. Results (ii) and (iii) are discussed in terms of structural short-range order in the amorphous state. For the purpose of comparison, a similar calculation is made for crystalline Pb, it is found that there is no unambiguous enhanced $\alpha^2F(\omega)$ in the low-ω region.

2774 P.M. Grant, "Signal Processors Based on Combined Charge Coupled Devices and Surface Acoustic Wave Devices."

Signal processors based on combined Charge Coupled Device (CCD) and Surface Acoustic Wave (SAW) components are reviewed. Emphasis is placed on the realization of wide bandwidth (10 MHz) Fourier transform processors, with many transform points ($> 10^3$). Design approaches interfacing untapped CCD shift registers for time compression with SAW chirp transform processors are reported. Other designs based on multiplexed CCD, CZT's or Coherent Memory Filters are also described. These CCD-SAW Fourier analyzers are shown to have application as temporal processors for Radar Doppler filtering. The potential impact of one and two dimensional spatial transform processors for Sonar beam forming is also examined.

2776 J. Fraser, G.S. Kino, and J. Birnholz, "Cepstral Signal Processing for Tissue Signature Analysis."

The reflected signal received by an ultrasonic transducer is modeled as a convolution of a transducer response with a reflection function for the target region. Cepstral analysis translates that signal into a domain where those components interact additively rather than through convolution and where separation can be accomplished with simple bandpass filtering operations. The cepstral transform of the pulse echo signal also provides direct access to any periodic behavior of reflectors arising from their spacing. As an example of these capabilities, the technique is used experimentally to describe the characteristic spacing of macrostructural reflecting elements in the pig liver *in vitro* and to determine the frequency dependent attenuation behavior of normal human liver *in vivo*.

2777 B.T. Khuri-Yakub, A.G. Evans, G.S. Kino, and B.R. Tittmann, "Acoustic Surface Wave Scattering: The Detection of Surface Cracks in Ceramics."

An acoustic surface wave technique for detecting surface cracks in ceramics has been devised. The technique has been demonstrated to detect cracks at least as small as 60 μm in depth, with the detectability limit for individual cracks being imposed by the size distribution of the adjacent background cracks. The attenuation of the surface wave has also been attributed (at least in structural ceramics) to the surface cracks, and preliminary correlations between attenuation and the large extremes of the crack size distribution have been reported.

G.L. No.

2778 L.J. Zych, J. Lukasik, J.F. Young, and S.E. Harris, "Laser-Induced Two-Photon Blackbody Radiation in the Vacuum Ultraviolet."

We report experimental measurements on a new type of vacuum-ultraviolet radiation source. It is shown that the maximum source brightness, within its narrow linewidth, is that of a blackbody at the temperature T of a metastable storage level. The laser-induced emission at 569 Å from a He glow discharge corresponded to a metastable temperature of 22,700°K and was over 100 times brighter than the 584-Å He resonance line.

2779 W.A. Harrison, "Theory of Polar Semiconductor Surfaces."

Effective atomic charges of atoms at the surface and in the bulk of a polar semiconductor are systematically calculated by modifying the nuclear charges of a homopolar semiconductor and estimating the electronic charge redistribution. Poisson's equation is then integrated through the surface to determine possible charge accumulation or possible dipole layers, both of which are assumed energetically unfavorable. Finally, the simplest surface geometry is sought which contains neither. A planar (though reconstructed) surface is favorable on a (110) face, but we obtain a (111) As face with an overlayer, corresponding to one quarter of an atomic plane of Ga . A similar overlayer was suggested by Nosker, Mark, and Levine but it is proposed here that the Ga atoms are in bridging positions saturating three quarters of the dangling As hybrids. A corresponding geometry with Ga and As interchanged is anticipated for the (111) Ga surface. These are consistent with the observed 1×1 on (110) and 2×2 on (111) Ga , but the observed 1×1 on (111) As must be attributed to randomization of the pattern since a true 1×1 gives charge localization. On the (100) surface the simplest favored geometry is a 1×4 pattern two atom layers deep and analogous to the Webb model of the 2×1 reconstruction on silicon (100) surfaces. The observed centered 2×8 is not consistent with a favored pattern less than four atom layers deep.

2780 T.W. Hänsch, "New Methods of Laser Spectroscopy."

New techniques of nonlinear laser spectroscopy provide powerful tools for studies of atoms and molecules: Coherent two-photon excitation with multiple light pulses produces narrowband spectral interference fringes and strongly enhanced resonant signals, and holds promise for very high resolution spectroscopy of atomic hydrogen. Laser polarization spectroscopy is a method of Doppler-free spectroscopy, which greatly surpasses saturated absorption spectroscopy in sensitivity, by monitoring the nonlinear interaction of two laser beams in a gas via changes in light polarization rather than intensity. The method has been very successfully used for a study of the hydrogen Balmer β line. Polarization labeling with laser light can unravel the complexities of molecular absorption spectra by identifying all absorption lines with a common lower level.

G.L. No.

2781 J. Fraser, B.T. Khuri-Yakub, and G.S. Kino, "The Design of Efficient Broadband Wedge Transducers."

A simple coupled-mode theory has been developed for acoustic-surface-wave wedge transducers. Surface-wave transducers have been fabricated to operate on aluminum using water as the wedge material. The measured efficiency was 68% at 2.75 MHz, the theoretical value being 81%. Transducers have also been fabricated to operate on glass with a rubbery solid, RTV 615, as the wedge material. The experimental and theoretical efficiencies of this transducer at 3.2 MHz were 35 and 50%, respectively. The surface-wave leakage coefficient of RTV 615 on glass has been measured and found to be in excellent agreement with theory.

2782 A.L. Schawlow, "Laser Interactions with Materials."

Some of the phenomena occurring when a laser light beam strikes a solid are considered, with special attention to infrared light and opaque materials such as metals. If the light is absorbed, very rapid heating can occur, followed by melting and removal of materials by vaporization or expulsion. Highly reflecting metals like copper can become absorptive at high intensities, by a number of processes whose relative importance depends on such factors as the power density, pulse length, the absorptivity and the ambient medium. At still higher power levels, the material may be shielded for a time by a plasma cloud above the surface. Deformation of the molten surface can also increase the absorption of laser light.

2786 W.R. Green and R.W. Falcone, "Inversion of the Resonance Line of Sr^+ Produced by Optically Pumping Sr Atoms."

We report inversion and lasing on the optically pumped resonance line of Sr^+. A mode locked frequency doubled dye laser was tuned to excite the dipole allowed two-electron transition $5s^2\ {}^1S_0 - 4d5p\ {}^3P^0_1$ in Sr vapor. The same laser then ionized the excited atoms, selectively producing ions in the $Sr^+\ 5p\ {}^2P^0_{3/2}$ excited level. The inversion density with respect to the Sr^+ ground level was approximately 10^{13} cm^{-3}.

2788 D.F. Moore, "Electron Tunneling into the A15 Superconductors: Nb_3Sn, V_3Si, and Nb_3Ge."

This thesis describes oxide-layer tunnel junctions which have outstandingly good quasiparticle (Giaever) and pair (Josephson) tunneling characteristics. The junctions we make on thin films of the superconductors niobium-three-tin and vanadium-three-silicon are greatly superior devices to any other junctions on high critical temperature superconductors in the A15 crystalline phase reported in the literature.

The good thin films made in the multi-electron-beam coevaporation system at Stanford are the secret behind this success. Satisfactory tunneling barriers form by oxidation of the evaporated niobium-tin films in air at room temperature before deposition of a lead or aluminum counter-

G.L. No.

2788 (continued)

electrode. In the case of vanadium-silicon the thermal oxide produces junctions with very poor current-voltage characteristics. However, the deposition of an extra silicon layer between two and sixteen nanometers thick on the fresh vanadium-silicon films before exposure to air results in excellent tunnel junctions.

Tunnel junctions with artificial (silicon with a silicon oxide layer) barriers are made on both niobium-tin and vanadium-silicon. This technique for controllably fabricating barriers may have importance in the industrial application of the A15 superconductors for device manufacture.

We study the superconductive properties such as the energy gap and critical temperature as a function of composition of the A15 films. The junctions on niobium-tin are suitable for a quantitative study of the tunneling density of states. From the data we calculate the electron-phonon spectral function which describes the interaction responsible for superconductivity. It is interesting that as the composition is changes from twenty-five to twenty atomic percent tin, niobium-tin changes from a strong-coupling superconductor with a high critical temperature to a weak-coupling superconductor with a low critical temperature.

Another study made possible by the availability of excellent junctions on the A15 superconductors is an examination of their low field behavior. We observe delayed fluxoid entry and the existence of a surface barrier of order one hundred and seventy milliTesla in niobium-tin and vanadium-silicon. These data help explain the potential utility of the A15 superconductors in power transmission line and resonant cavity applications.

2790 V. Jipson and C.F. Quate, "Acoustic Microscopy at Optical Wavelengths."

Recent advances in the field of acoustic microscopy have allowed the instrument to be operated at wavelengths that correspond to the center of the optical band. Experimental results in the form of acoustic micrographs are presented and compared to their optical counterparts. It is apparent that the resolving power of the instrument is similar to that of the optical microscope. Also it is seen that the acoustic micrographs yield information on the subsurface region. This information is not available in the optical image.

G.L. No.

2793 W.P. Leung, "Acoustic Imaging with a 100-Element Electronically Scanned and Focused Phased Array."

This report describes the development and applications of an acoustic imaging system containing a 100-element phased receiving array which can scan and focus electronically. Most of the experiments were carried out at frequencies around 2.5 MHz although frequencies as high as 6.4 MHz were used. High sensitivity and resolution of approximately 1 mm were obtained. Two-dimensional acoustic images are formed with the object illuminated by a sheet beam from a strip acoustic transducer. Radiation scattered from the object is detected by the receiving array, which scans electronically along a line parallel to the strip transducer, and the object is moved mechanically in the perpendicular direction to produce a frame scan. Because of the large number of elements and large aperture in the receiving array, a field of veiw of approximately 2-1/2" and as many as 100 resolvable spots per scan line are obtained.

The electronic focusing and scanning in the receiving array are achieved by using a traveling FM chirp signal on a surface acoustic wave delay line as the phase reference. The focal length of the receiver is proportional to the slope of the FM chirp and the scanning speed is approximately equal to the speed of the FM chirp traveling in the surface acoustic wave delay line. For the present system, the focal length can vary from 15 cm up to more than a meter and the scanning speed is approximately 1.2 mm/μs. Because of the high scanning speed of the receiving array, the time required to scan a sample is completely determined by the speed of the mechanical scan. In general, an acoustic image of an object can be obtained in less than a second.

This acoustic imaging system is very flexible. It can be operated either in transmission, reflection or phase contrast modes. In the transmission or reflection mode, the sidelobe level of the receiving array can be greatly improved by means of range gating although the scanning speed is reduced at the same time. We have developed two different types of phase contrast techniques for this system. The first type measures the first derivative of the phase profile of an object while the second type detects the direct spatial phase variations. The first type is more suitable for objects with acoustic impedance close to that of water and the second type is geared toward objects with large acoustic impedance compared with that of water. Therefore, these two tvpes of phase contrast technique are complementary to each other.

We have used this acoustic imaging system to examine some industrial materials. We are able to detect all known defects in the bondings of planar laminate panels of boron fibers bonded to titanium plates, supplied to us by North American Rockwell, at a speed two orders of magnitude faster than conventional methods. We are also able to

G.L. No.

2793 (continued)

detect some of the defects in honeycomb structures, which are very important in the aircraft industry. With the differential phase contrast mode, we are able to detect acoustic phase shifts smaller than 20° in plastic samples. With the double-pulse mode, acoustic velocity variations smaller than 1 part in 10^4 in metal samples can be resolved. As a result, changes in acoustic velocity introduced by stress or strain can be detected by this technique. Recently, two-dimensional images of residual stress and strain patterns in aluminum disk samples have been obtained. These are believed to be the first quasi-real time acoustic images of this kind.

2794 F.V. Kowalski, W.T. Hill, and A.L. Schawlow, "Saturated-Interference Spectroscopy."

The background in saturation spectroscopy is decreased by balancing the probe beam, in amplitude and phase, against a second probe, using a configuration like a Jamin interferometer. This improves the signal-to-noise ratio. If the phase is adjustable to provide best balance while the laser is tuned, the signal is proportional to the square of the absorption, and the linewidth is accordingly reduced.

2795 J.C. White, "Inversion of the Na Resonance Line by Selective Photodissociation of NaI."

This Letter reports the inversion and intense superfluorescent emission of the Na resonance line by selective photodissociation of NaI. The fifth harmonic of a Q-switched Nd:YAG laser at 2128 Å was used to photodissociate NaI to the unbound state $Na(3p^2P) + I(5p^5\ ^2P_{3/2})$. Superfluorescence at the 5896 Å resonance line was observed.

2798 J.N. Eckstein, A.I. Ferguson, and T.W. Hansch, "High Resolution Two-Photon Spectroscopy with Picosecond Light Pulses."

We have demonstrated the feasibility of Doppler-free two-photon spectroscopy with a train of picosecond standing wave light pulses from a synchronously pumped mode-locked cw dye laser. The actively controlled mode spectrum provides a means for accurate measurements of large frequency intervals. From a multipulse spectrum of the sodium 3s-4d transition we have determined a new value of the 4d fine structure splitting, 1028.5 ± 0.4 MHz.

G.L. No.

2800 Peter Borden, "The Storage Correlator: Theory and Signal Processing Applications."

This report presents a complete analytic theory of the acoustoelectric storage correlator, and experimental applications which demonstrate its versatility as a signal processor. Within the storage correlator, externally applied signals interact with the potentials associated with an acoustic surface wave traveling on a piezoelectric substrate. A spatially varying charge pattern is thereby stored in a linear array of semiconductor diodes. Application of a later reading signal yields the convolution or correlation of the reading signal and the stored charge pattern.

A number of modes of both storing the charge pattern and reading it have been reported. The theory provides analytic predictions of the device performance for most of these modes of operation and most reported device structures. Experimental confirmation of the theory is given.

Particular attention is paid to the transient characteristics of p^+n diodes. It is shown both theoretically and experimentally that their response is nearly equivalent to that of fast diodes (e.g., Schottky diodes) in this application. As a consequence, they may be charged quickly (in nanoseconds) and can retain their charge for long times (seconds).

A working device has been demonstrated. Key details of its construction are discussed. Particular attention is paid to methods for reducing spurious signal generation and to an evaluation of alternate diode array structures.

A variety of signal processing results are presented to demonstrate the storage correlator's versatility as a signal processor. Correlations performed with various phase coded sequence indicate the device's capabilities and limitations. A system application is shown, in which it is used as a phase distortion filter to enhance the resolution of an acoustic pulse-echo system. Novel applications, such as an electronically variable tapped delay line and a variable pulse expander are described. Finally, the device is used to correlate input signals. In many applications, this technique increases the effective time-bandwidth product severalfold.

2804 R. A. Baumgartner and R. L. Byer, "Remote SO_2 Measurements at 4 μm with a Continuously Tunable Source."

Remote atmospheric measurements of SO_2 were performed using a differential absorption lidar with a continuously tunable $LiNbO_3$ parametric oscillator and amplifier source in the 4.0-μm region. A comparison of injected gas concentration in a remotely located sample chamber with the lidar measurements through the chamber showed measurement agreement within experimental error and a detection sensitivity for SO_2 of 0.9 part in 10^6 km.

G.L. No.

2806 G.S. Kino, J.B. Hunter, G.C. Johnson, A.R. Selfridge, D.M. Barnett, G. Herrmann, and C.R. Steele, "Acousto-elastic Imaging of Stress Fields."

An acoustic technique for measuring inhomogeneous stress in externally loaded solids is described. This method requires a measurement of transit time of a longitudinal acoustic wave through a stressed thin metal specimen using a small diameter water coupled acoustic transducer. The transducer is mechanically scanned over the surface of the sample by a computer controlled system and transit time measurements are made at discrete points. Predictions of velocity variation with stress using the theory of nonlinear elasticity are employed to relate acoustic transit time to stress levels at field points in the specimen. Stress field contour plots are developed and compared with theoretical results. Samples investigated include uniaxial tension specimens of aluminum and steel, an aluminum plate containing a central hole, and a double edge-notched aluminum panel, both under far-field tension.

2808 B.A. Auld, "General Electromechanical Reciprocity Relations Applied to the Calculation of Elastic Wave Scattering Coefficients."

General electromechanical reciprocity relations are applied to the calculation of elastic wave scattering coefficients observed at the electrical terminals of the transducer used in performing an experiment. Both direct backscatter and two transducer geometries are considered. The general formulation is applicable to anisotropic media, but is applied as an example to Rayleigh wave scattering from a surface-breaking crack on an isotropic substrate. This method of analysis is applicable to both the Born and quasistatic approximation and is valid for bulk, Rayleigh and plate wave transducers using any single transduction mechanism.

2810 S.E. Harris and J.F. Young, "Rapid Laser Induced Energy Transfer in Atomic Systems."

We describe experimental and theoretical results on two related methods of rapidly transferring stored population from metastable states to selected target states of a different species. These are the laser induced or switched collision, and laser induced two-photon spontaneous emission.

When the energy defect between initial and final states of two colliding atoms is large with respect to kT the cross section for inelastic collision is small. A switched collision process utilizes one or more photons to conserve energy and can result in large cross sections into selective states. Numerical calculations show that the effect maximizes for a laser frequency corresponding to the energy difference of the relevant states of the infinitely separated atoms. Experimental results are presented which verify this prediction.

G.L. No.

2810 (continued)

The laser induced two-photon spontaneous source is particularly suited to the vacuum ultraviolet spectral region. Population is stored in the metastable level of a selected species, at an energy of $\hbar\omega_{21}$; a tunable laser of frequency ω_p then induces radiation at frequencies $\omega_{VUV} = \omega_{21} \pm \omega_p$ which is tunable, narrow band, of short timescale, and very bright. Experimentally we have used a He glow discharge and a mode-locked Nd:YAG laser to create a source at 569 Å with a brightness over 100 times that of the He 584 Å resonance line.

2813 P.D. Corl, G.S. Kino, C.S. DeSilets, and P.M. Grant, "A Digital Synthetic Focus Acoustic Imaging System."

A new real time synthetic focus digital acoustic imaging system has been developed. It operates by exciting, with an impulse, one element of a transducer array, digitizing the return echo and storing it in a Random Access Memory. This process is repeated for all the array elements and using the focus information which has been loaded from the mini computer, the system generates a series of swept-focus lines perpendicular to the array face. In comparison to earlier computer based dystems, our processor handles data at rates sufficient to generate real time images.

As only one transducer at a time is excited, it has been necessary to develop a high efficiency broadband transducer array with quarter wavelength matching layers. The array we have developed has an 11 dB return loss, a 2.7 — 4.3 MHz frequency range with an impulse response approximately 2-1/2 cycles long. The digital processor operates at a 10 — 16 MHz sample rate with 8-bit quantization. Theoretical and experimental results are presented for a system with a 96 line display employing 8 and 32 active transducer elements.

2814 V. Domarkas, B.T. Khuri-Yakub, and G.S. Kino, "Length and Depth Resonances of Surface Cracks and Their Use for Crack Size Estimation."

Angular scattering from surface cracks has been used for determining the length of a surface crack. This technique assumes the physical availability of space to carry out an angular scattering experiment, and makes no estimation of the depth of the crack. In this work, we report a new technique where the scattering from surface cracks is made versus frequency, at one angle of incidence only. Length and depth resonances of the crack are observed and used to estimate the crack geometry. We made our measurements on EDM notches in steel. The geometry of the crack has been predicted with an accuracy of 10 - 20%.

G.L. No.

2815 G.S. Kino, T.M. Waugh, P.D. Corl, C.S. DeSilets, and P.M. Grant, "Acoustic Imaging Techniques for Nondestructive Testing."

A review will be presented of our real time analog and digital phased array B scan acoustic imaging systems. We will discuss the recent results taken with our analog FM chirp focused system operating in the gated mode. This technique removes completely the sidelobes which have degraded earlier systems. With it we have been able to obtain acoustic images in metal samples with surface waves, Lamb waves, shear waves, and longitudinal waves. We have detected small reflectors of less than 1 mm diameter in the neighborhood of an end wall and have obtained images of small cracks, both when they are placed parallel and at large angles to the acoustic array. The principles of two alternate digital imaging systems, one based on chirp focusing and the other a synthetic aperture approach will also be described. The latter system samples and stores the return echo signals in digital memories for subsequent processing, in real time, to produce the focused image only. The principles of these systems will be described here.

2819 S.E. Harris, J. Lukasik, J.F. Young, and L.J. Zych, "Anti-Stokes Emission as a VUV and Soft X-Ray Source."

A VUV and soft x-ray light source based on *spontaneous* anti-Stokes scattering from atomic population stored in a metastable level is described. Unique properties of this source include: narrow linewidth, tunability, linear polarization, picosecond time scale, and quite high spectral brightness. We show how the maximum source brightness, within its narrow linewidth, is that of a blackbody at the temperature T of a metastable storage level. Experimental results showing laser induced emission at 569 Å and 637 Å from a He glow discharge are described. The use of the anti-Stokes process for direct, internal energy transfer from a storage species to a target species is discussed.

2821 R.E. Teets, "Polarization Labeling Spectroscopy of Molecules."

A new method of molecular spectroscopy, called polarization labeling spectroscopy, has been developed to allow one to study molecules in a specific rotational-vibrational ground state level, without interference from molecules in nearby levels. A polarized pump laser is used to orient molecules in a specific level by optical pumping. This effectively labels these molecules, and they can be sensitively detected by their effect on the polarization of a probe laser. By probing with a very broad band laser, a large portion of the absorption spectrum of the labeled state can be recorded. This spectrum gives direct information about the spacings of the excited state levels, which are difficult to determine by conventional methods.

G.L. No.

2821 (continued)

Polarization labeling was investigated by taking spectra of the sodium dimer. The spectra showed the simple rotational and vibrational structure of the excited states. In addition, the simplicity of the spectra allowed the first direct observation of a forbidden transition to the $a^3\pi$ state which perturbs the $A\ ^1\Sigma_u^+$ state. Collisional transfer of the orientation to nearby rotational levels was also observed. The much more complicated structure of the excited states of nitrogen dioxide was investigated using polarization labeling. The spectra clearly demonstrate the highly perturbed character of these states. Although the spectra were too complex to allow assignment of upper state vibrational quantum numbers, the rotational assignments for many lines could be made. No evidence for two step excitation to higher excited states was found.

This method is very similar to the technique of polarization spectroscopy introduced by Wieman and Hänsch for high resolution spectroscopy. Their method uses a polarized pump laser to label the zero axial velocity atoms in a gas. The probe spectrum of these atoms is then free of Doppler broadening. In this thesis, the theory of polarization is extended to include both linear and circular pump polarization. By comparing the spectra taken with the two types of polarization, one can easily distinguish Q branches ($\Delta J=0$) from P and R branches. This can be very useful since the strength of Q branch transitions depends on the symmetries of the molecular states. Polarization spectroscopy with a single mode argon laser was used to obtain the first Doppler-free spectra of nitrogen dioxide in a cell. The resolution of the hyperfine structure was somewhat better than results from molecular beam experiments, although the sensitivity of the beam experiments was better.

2822 M.T. Resch, B.T. Khuri-Yakub, G.S. Kino, and J.C. Shyne, "Stress Intensity Factor Measurement of Surface Cracks."

An acoustic technique for measuring the maximum stress intensity factor of a surface crack is described. Using glass samples, we have formed surface cracks, carried out the measurements with a surface acoustic wave probe, and predicted the fracture stress of the glass. For small enough cracks, the predicted fracture stress is less than 5% in error from the measured fracture stress.

2823 G.S. Kino, J.B. Hunter, G.C. Johnson, A.R. Selfridge, D.M. Barnett, G. Herrmann, and C.R. Steele, "Measurement of Stress Fields in Metals."

An acoustic technique for measuring inhomogeneous stress in externally loaded solids is described. This method requires a measurement of transit time of a longitudinal acoustic wave through a stressed thin metal specimen using a small diameter water coupled acoustic transducer. The transducer is mechanically scanned over the surface of the sample by a computer controlled system to take stress field contour plots. The results compare well with theory.

G.L. No.

2824 G.S. Kino, "Acoustic Imaging for Nondestructive Evaluation."

The application of acoustic imaging techniques to nondestructive testing of materials is discussed. After a description of the standard NDT techniques employed in the field and some examples of mechanically scanned imaging devices, most of the paper is devoted to a description of electronically scanned and focused systems. As holographic techniques are described by Metherell in an accompanying paper, they are not discussed here. It is shown that the use of imaging techniques makes it possible to locate the position of flaws quickly and accurately.

2825 Y. Murakami, B.T. Khuri-Yakub, G.S. Kino, J.M. Richardson, and A.G. Evans, "The Application of Adaptive Filtering to Defect Characterization."

The inverse problem of defect characterization has typically been carried out by comparing back scattered or angular scattered power spectra to theoretical expectations in the frequency domain. Instead, we carry out such a comparison in the time domain where more insight can be gained as to the source and amplitude of the returning echoes. Working with defects in ceramics with pulse lengths of the order of 2 ns, the acoustic signals are digitized and fed into a digital computer. A Wiener filter is designed to match the transducer response, so the impulse response of the system approaches a delta function. The total bandwidth above the noise level of the transducer is being used instead of the 3 dB bandwidth, thus giving a great improvement in the depth resolution. We have carried out theoretical calculations on the response of defects in ceramics which indicate that different inclusions can be easily identified by this means. Experimental results on real defects are presented which demonstrate the power of such a technique for defect characterization.

2826 W.A. Harrison, "Fifty Years of Metals Theory."

Metallic properties have been attributed to free electrons almost since the discovery of the electron in 1897. This became a theory of metals when Bloch and Sommerfeld applied quantum theory to these electrons in 1928, providing the basis for the subsequent developement of the theory. That development was, however, not by a direct process of deduction but required genuinely new concepts in order to become simple and understandable. Four such concepts are discussed here: the quasiparticle state of the electron, the representation of its strong interaction with the atoms by a weak pseudopotential, the formation of a local magnetic moment by itinerant electrons, and the superconducting order through which the electrons produce the superconducting state.

2828 Y. Murakami, B.T. Khuri-Yakub, G.S. Kino, J.M. Richardson, and A.G. Evans," An Application of Wiener Filtering to Nondestructive Evaluation."

The inverse problem of defect characterization is carried out by comparing theoretical and experimental return echo pulses. Acoustic echo signals of the order of 2 ns long are digitized and fed

G.L. No.

2828 (continued)

into a digital computer. A Wiener filter is designed to match the transducer response, so the impulse response of the system approaches a delta function. Experimental results on defects in Si_3N_4 ceramics are presented which demonstrate the power of such a technique for defect characterization.

2830 A.I. Ferguson, J.N. Eckstein, and T.W. Hänsch, "A Subpicosecond Dye Laser Directly Pumped by a Mode-Locker Argon Laser."

We report on a mode-locked cw dye laser which reliably produces light pulses as short as 850 femtoseconds. Short pulse operation depends critically on the stability and spectral purity of a frequency synthesizer which generates the radiofrequency signal for the acousto-optic mode-locker of the argon pump laser. The regular axial mode spectrum of the dye laser extends over 500 GHz and can provide an accurate calibration scale for the spectroscopic measurement of large frequency intervals. The high stability of the locked modes has been demonstrated by observing Doppler-free multiple-pulse two-photon spectra of the sodium 3S-5S transition with linewidths as narras as 4 MHz.

2831 J.N. Eckstein, "High Resolution Spectroscopy Using Multiple Coherent Interactions."

We demonstrate a new technique of Doppler-free high resolution spectroscopy that makes use of the coherent excitation of atoms in a gas by a train of pulses. The frequency resolution is much greater than that obtained with a single pulse. The pulse train is tuned to be resonant with an atomic two photon transition, and by an appropriate mirror configuration the atoms see a periodic sequence of standing waves, causing the excitation to be Doppler-free. The frequency spectrum of such a train of pulses consists of a set of discrete modes, separated exactly by the inverse of the period of the pulse train, namely $1/\tau$. Resonant multiple pulse two photon excitation occurs, as the mode spectrum is scanned, when the mode pattern is symmetrically placed around one half the transition frequency. Since the modes are precisely space apart in frequency, many pairs of modes can then simultaneously satisfy the condition that their sum frequency equals the two photon transition frequency. If two atomic two photon transitions lie under the frequency spectrum of a single pulse, scanning the mode spectrum by only $1/2\tau$ will cause both transitions to have been excited, permitting frequency splitting measurements over large frequency intervals to be made, modulo $1/2\tau$.

Two experimental arrangements were used. In one, a single pulse, tuned to excite the Na 3s to 5s transition, was injected into an optical resonator containing Na atoms near one mirror. The sequence of standing waves was formed as the front edge of the pulse overlapped its tail on each round trip. Coherent multiple pulse two photon excitation

G.L. No.

2831 (continued)

was observed as the mode frequencies were scanned by slowly changing the length of the resonator. In the other case, a train of picosecond pulses from a continuous, synchronously pumped mode locked dye laser was used. As the mode spectrum was scanned resonances as narrow as 4 MHz were observed due to simultaneous excitation by several thousand modes. Since the intermode spacing is precisely controlled by the active mode locker, driven by a stable radio frequency oscillator, self calibrated splittings can be reliably measured over frequency ranges as large as several hundred GHz with only the uncertainty characteristic of frequency measurements of less than 100 MHz. With this technique we have determined a more accurate value for the Na 4d fine structure splitting, namely 1028.5 ± 0.4 MHz, which is about 10 times as precise as the previous optical measurement using a single mode laser. We have also demonstrated the feasibility of self calibrated polarization spectroscopy using the well defined mode spectrum from the mode locked laser. This is the one photon analog of self calibrated two photon spectroscopy.

Multiple pulse spectroscopy also offers the advantage that efficiencies for second harmonic generation are dramatically enhanced, since, for a given average power, the peak power is increased by a factor of τ/t_o where t_o is the pulse duration. For typical mode locked dye lasers, with only, say, 100 mW average power, peak powers can be as great as 700 W, causing SHG efficiencies to be around 10%, typically 10^3 to 10^4 greater than for single mode light. Two-photon excitation with such a doubled train of pulses should give 10^7 times the excitation rate with the better frequency resolution than a single mode laser would offer.

2832 F.V. Kowalski, "New Methods in Laser Spectroscopy."

A wavemeter capable of measuring the absolute wavelength of cw laser radiation to one part in 10^8 is described. It consists of a two-beam interferometer in which fringes, from a standard and unknown laser, are counted simultaneously as one arm of the interferometer is moved. The standard and unknown beams travel identical paths in opposite directions. Therefore, any vibrations of the interferometer effect both fringe patterns equally. The laser beams emerge at separate detectors so that there is no need for a dichroic beam splitter to separate them and measurements can be made close to the wavelength of the standard if desired. Moreover, the visible spots of light on the mirrors can be brought into coincidence, ensuring that the two path lengths are nearly identical. We also discuss the possibilities of data processing that would employ the same wavemeter to measure pulsed laser sources.

Saturated Interference Spectroscopy, a technique to increase the signal-to-noise ratio in saturation spectroscopy, is introduced. This method involves the interference of two probe beams whose phase and intensity can be controlled independently in a Jamin interferometer. Since the saturating beam travels in the opposite direction of one of the probe beams,

G.L. No.

2832 (continued)

the probe is modulated only when both beams are tuned to interact with atoms of nearly zero axial velocity. The method is therefore free from Doppler broadening. In the present technique, the interference pattern of the two probes gives nearly zero intensity until the line is saturated. If the phase is adjusted to provide minimum intensity of the interference pattern while the laser is tuned, the signal is proportional to the square of the absorption and the line width is accordingly reduced. Possible applications and other methods of increasing the signal-to-noise ratio with this technique are discussed.

Finally, an experiment to find and identify two-photon transitions in molecular sodium is described. This involves the use of polarization labeling incorporating delays between the pump and broadband probe beam. Three states, two of which have not been observed before, are reported. Preliminary molecular constants are also given.

2833 C.S. DeSilets, "Transducer Arrays Suitable for Acoustic Imaging."

The design and development of piezoelectric transducer arrays suitable for use in electronically scanned and focused acoustic imaging systems is described. These arrays are designed to operate in the frequency range 2 - 5 MHz within 45% to 80% fractional bandwidth. Linear arrays of up to 180 elements have been built and used extensively in acoustic imaging systems. Particular attention is placed on achieving high transduction efficiency and angular beamwidths of at least ±15°.

Design techniques based on the transmission line model of the transducer of Krimholtz, Leedom, and Matthaei are formulated for achieving efficient, broadband operation. These techniques involve the use of quarter-wave matching layers between a high impedance ceramic and a low impedance load. Broadband matching criteria are generated, and a novel technique for selecting the quarter-wave matching layer impedances is described. The theoretical transient response of the transducer is obtained by taking the Fourier transform of the transfer function of the transducer. An experimental transducer built using the formulated design techniques is described and its characteristics compared to theory.

Slotted transducer arrays employing tall, narrow elements are described. A one-dimensional model of this kind of element is formulated, and the effects of coupling between element resonant modes are examined. A variational theory for the effective radiation impedance of a narrow element is formulated, and the effect of this impedance

G.L. No.

2833 (continued)

on the transducer characteristics is described. Experimental results with simple, highly backed arrays of 100 to 120 elements as well as an 180 element double quarter-wave matched array are compared with the theoretical predictions. A brief description of the effects of array cross-coupling on the element spatial frequency response is included.

The theory of unslotted, monolithic transducer arrays is presented along with experimental results with simple, highly backed monolithic arrays. Problems with achieving a uniform spatial frequency response for an array of high acoustic impedance elements radiating into a low impedance load are detailed. An application of this type of array using low acoustic impedance material, PVF_2, is shown. The broad and uniform angular response of a ceramic monolithic array radiating into metal is demonstrated.

2834 B.A. Auld, G. Elston, and D.K. Winslow, "A Novel Microwave Ferromagnetic Resonance Probe for Eddy Current Detection of Surface Flaws in Metals."

A new type of eddy current probe has been developed for detecting surface flaws in metals. By contrast with traditional devices it operates at microwave frequencies and uses an yttrium iron garnet (YIG) ferromagnetic resonator. Such resonators experience a frequency shift when brought into proximity with a metal surface because of the perturbation of the microwave field external to the resonator. A crack in the metal disturbs the surface currents and produces an additional perturbation of the frequency. This paper reports the basic principles of operation and results of experiments performed on machined slots in aluminum. Fractional frequency shifts as large as 0.5% were observed for a slot with an opening 115 μm wide. An unloaded fatigue crack in a nonmagnetic stainless steel test sample was also easily detected, in accord with the simple theory, which predicts a response proportional to the slot opening.

2835 P.M. Grant and G.S. Kino, "Adaptive Filter Based on SAW Monolithic Storage Correlator."

Design of a wideband adaptive filter incorporating a Surface Acoustic Wave monolithic zinc-oxide-on-silicon storage correlator is reported. Its operation is demonstrated with experimental measurements of CW interference suppression in a simulated spread spectrum system. These processors, which are capable of adaptive filtering over 1 - 20 MHz signal bandwidths in real time, offer significant advantages in terms of complexity and power consumption over equivalent digital systems.

G.L. No.

2836 R.A. Baumgartner and R.L. Byer, "Continuously Tunable IR Lidar with Applications to Remote Measurements of SO_2 and CH_4."

Remote atmospheric measurements of SO_2 and CH_4 were performed using a differential absorption lidar with a continuously tunable $LINbO_3$ parametric oscillator and amplifier source in the 1.4 - 4.0 μm region. A comparison of injected gas concentration in a remotely located sample chamber showed excellent agreement with a SO_2 detection sensitivity of 0.9 ppm-km. An ambient level measurement of methods at the 1.66 μm overtone transition gave 3.9 ± 0.7 ppm. Performance predictions indicate an order of magnitude gain in sensitivity is possible with recently demonstrated tunable source improvements. The wide tuning range capability allows the measurement of numerous other pollutant molecules in the 1.4 - 4.0 μm region.

2837 R.W. Falcone, J.R. Willison, J.F. Young, and S.E. Harris, "Measurement of the He $1s2s\,^1S_0$ Isotopic Shift Using a Tunable VUV Anti-Stokes Light Source."

We describe a high resolution vacuum ultraviolet spectroscopic technique based on a tunable, narrow band, VUV, spontaneous anti-Stokes light source. The technique was used to measure the absolute energies of the $1s2s\,^1S_0$ states of ^3He and ^4He; the 1s2s S_0 level ^3He is 7.8 ± 0.5 cm^{-1} below that of ^4He.

2838 G.S. Kino, P.M. Grant, P.D. Corl, and C.S. DeSilets, "Digital Synthetic Aperture Acoustic Imaging for NDE."

Real time synthetic aperture or synthetic focus techniques for acoustic imaging have been investigated and a prototype digital imaging system has been developed. It operates by exciting, with an impulse, one element from a transducer array, digitizing the return echoes, and storing them in a Random Access Memory. When this process has been repeated for all the array elements, the focus information is loaded from a mini computer. The system then generates a series of swept-focus lines, which are arranged perpendicular to the array face. Our processor handles typical input data at rates sufficient to generate real time images.

As only one transducer at a time is excited it has been necessary to develop a high efficiency broadband transducer array with quarter wavelength matching layers. The array we have developed has an 11 dB return loss, a 2.7 - 4.3 MHz frequency range with a pulse response approximately 5 half cycles long. The digital processor operates at a 10 - 16 MHz sample rate with 8 bit quantization. Theoretical and experimental images will be presented for a system with a 96 line display employing 8 and 32 active transducer elements, which has a resolution of < 1 mm.

G.L. No.

2838 (continued)

We will also discuss methods of reducing the sidelobe responses in these systems. We have carried out experiments and theory, and we can considerably reduce the sidelobe level with input gain compression from the current experimental value of -12 dB to beyong -20 dB in our prototype 8 transducer system. In addition, we are investigating inverse filtering techniques for shortening the effective pulse length to 1 rf cycle to further improve the image quality and range resolution.

2843 H.K. Wickramasinghe, "Contrast and Imaging Performance in the Scanning Acoustic Microscope."

Several articles have been written on the subject of scanning acoustic microscopy. Nevertheless, apart from some specific papers dealing with reflection microscopy, little has been said about the various contrast mechanisms involved in the process of image formation, and the effects of parameters such as acoustic antireflection coatings on the lens surface and absorption in the water on the quality of the recorded image. This paper is devoted to an analysis of these problems. It is shown that in the amplitude mode of operation, the acoustic microscope acts as a phase contrast microscope and is sensitive to the local phase gradients in the object. Furthermore, it is shown that the effect of an acoustic antireflection coating on the lens surface is to substantially reduce the sidelobe amplitude of the focal distribution at the expense of a slight increase in the width of the main lobe. Experimental observations agree with theory.

2844 G.S. Kino, "Acoustoelasticity."

Two types of acoustic techniques for measuring mechanical properties of materials are described. One technique has made it possible to measure the stress intensity factor and hence predict the breaking strength of a brittle material (glass) accurately. The second technique has enabled us to measure stress profiles in metal samples and obtain results for the stress in the neighborhood of a crack or a hole which are in excellent agreement with theory.

2845 F.V. Kowalski, R.E. Teets, W. Demtröder, and A.L. Schawlow, "An Improved Wavemeter for CW Lasers."

We report on a modified version of our previous moving mirror wavelength measuring interferometer. Its accuracy has been experimentally confirmed to one part in 10^8. The device is simple and seems ideally suited for cw lasers.

G.L. No.

2846 R.E. Howard, D.A. Rudman, and M.R. Beasley, "Josephson Properties of Nb_3Sn/Pb Tunnel Junctions."

The Josephson properties of Nb_3Sn/Pb tunnel junctions formed on electron-beam-deposited Nb_3Sn are reported. The junctions are found to have large gaps, low leakage, and a much lower specific capacitance than Josephson junctions incorporating Nb base electrodes.

2850 H.K. Wickramasinghe, R.C. Bray, V. Jipson, C.F. Quate, and J.R. Salcedo, "Photoacoustics on a Microscopic Scale."

We have modified a transmission acoustic microscope by replacing the input lens with an optical counterpart. The input to this system comes from a mode-locked and Q-switched Nd:YAG laser at 1.06 μm. Acoustic signals arising from thermoelastic coupling are generated in metallic films at frequencies determined by the modulation envelope of the optical beam. The output acoustic lens and transducer responsive to sound waves at 840 MHz, detect the acoustic energy which comes from the heated volume (~ 2 μm diameter) near the focal region. The sample is mechanically scanned through the focal point in a raster pattern to record the photoacoustic images. We suggest this as a method for collecting new information on microscopic structures.

2851 M.T. Resch, B.T. Khuri-Yakub, G.S. Kino, and J.C. Shyne, "The Acoustic Measurement of Stress Intensity Factors."

The maximum stress intensity factor of a surface crack has been inferred by measuring the reflection coefficient of a Rayleigh wave incident to the crack. An acoustic surface wave wedge transducer was used to excite the incident wave, and to measure the reflected wave amplitude. The fracture stress of Pyrex glass specimens containing the acoustically measured cracks was determined in biaxial flexure. The values of the fracture stress predicted from acoustic data were found to be in excellent agreement with the measured values, with less than a 15% error.

2853 J.C. White, G.A. Zdasiuk, J.F. Young, and S.E. Harris, "Observation of Radiative Collisional Fluorescence."

We report the observation of spontaneous radiative emission during the collision of two excited Ba atoms. The emission occurs at the sum energy of the excited atoms and is the emission analog of the laser induced inelastic collision process. We measure a collision cross section for de-excitation by spontaneous radiative emission of $2.6 \times 10^{-20} cm^2$.

G.L. No.

2855 S.J. Poon and J. Durand, "Magnetic Clusters Description of Spin Glasses in Amorphous La-Gd-Au Alloys."

The bulk magnetic properties of splat-cooled amorphous alloys of composition $La_{80-x}Gd_xAu_{20}$ ($0 \leq x \leq 80$) have been studied. Zero-field susceptibility, high-field magnetization (up to 75 kOe) and saturated remanence have been measured for temperatures ranging from 1.8 to 290°K. Detailed analysis of the data based on a magnetic cluster description of the spin-glass and micromagnetic alloys ($x < 56$) is presented. Our concentrated spin glasses are represented by rigid ferromagnetic clusters as individual spin entities interacting via random forces. Scaling laws similar to those of Blandin, Souletie, and Tournier for the magnetization are obtained and presented graphically for the $x \leq 32$ alloys in which $M/x = g(H/x^*, T/x)$, where x^* is the concentration of clusters. Saturation remanent magnetization is interpreted in terms of the dipolar anisotropy model of Tholence and Tournier. The strength of the Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction V_o between clusters (or single spins in the dilute alloys) is determined from high field magnetization data using the Larkin-Smith approach. The freezing temperatures T_M (defined by susceptibility maxima) of dilute spin glasses in which $T_M \alpha x$ are accounted for rather well using the experimentally determined values of V_o. An attempt is made to explain the freezing temperatures of more concentrated spin glasses in which $T_M \propto x^{1.3}$ ($12 \leq x \leq 40$). It is also shown that for the $x < 24$ alloys, the size of the clusters can be correlated to the structural short-range order in the amorphous state. More concentrated alloys are marked by the emergence of cluster percolation.

2857 R.L. Byer and W.R. Trutna, "16-μm Generation by CO_2-Pumped Rotational Raman Scattering in H_2."

We have generated 50 mJ of 16.9-μm radiation by simulated rotational Raman scattering in 3 atm of H_2 gas pumped by a CO_2 TEA-laser source. Threshold was reached by injection of a few microjoules of 16.9-μm radiation generated by four-wave mixing. We achieved 25% peak power, or 40% peak photon conversion efficiency.

2589 B.T. Khuri-Yakub, G.S. Kino, J.C. Shyne, M.T. Resch, and V. Domarkas, "Surface Crack Characterization: Geometry and Stress Intensity Factor Measurements."

The reflection coefficient of a Rayleigh wave at a surface crack is measured in both the long wavelength and the short wavelength limits. From the long wavelength measurement, the maximum value of the stress intensity factor is evaluated. Using glass samples, we have formed surface cracks, measured their reflection coefficient, and predicted failure stress with an error of less than 5% from the measured fracture stress. In the short wavelength limit, the reflection coefficient is measured versus frequency. Length and depth resonances of the crack are observed and used to estimate the crack grometry with an accuracy of 10-20% for EDM notches in steel.

G.L. No.

2862 P.D. Corl, P.M. Grant, and G.S. Kino, "A Digital Synthetic Focus Acoustic Imaging System for NDE."

A new real time synthetic aperture digital acoustic imaging system has been developed. It operates by exciting, with an impulse, one element of a transducer array, digitizing the return echoes and storing them in a Random Access Memory. After this is repeated for all elements, the system uses the focus information, which has been previously loaded from the minicomputer, to generate an image comprising a series of swept-focus lines perpendicular to the array face. As only one transducer at a time is excited, it was necessary to develop a high efficiency transducer array with quarter wavelength matching layers. The array we developed has an 11 dB return loss, with a 2.7-4.3 MHz frequency range. The digital processor operates at a 10-16 MHz sample rate with 8-bit quantization. Experimental results are presented for a system with a 96 line display employing 8 and 32 active transducer elements, to demonstrate its potential use in acoustic imaging for nondestructive evaluation of mechanical samples.

2863 E.W. Weber and J.E.M. Goldsmith, "Double-Quantum Saturation Spectroscopy in Hydrogen: Measurement of the $3\ P_{3/2} - 3\ D_{3/2}$ Lamb Shift."

Very narrow saturated double-quantum transitions ($2^2S - 3^2S$, 3^2D) have been observed for atomic H in a He-H_2 dc discharge using rf and a cw dye laser. The H ($3\ P_{3/2} - 3\ D_{3/2}$) Lamb shift has been measured directly by comparing single- and double-quantum saturation signals to be -5.5 (.9) MHz confirming that $3\ D_{3/2}$ lies lower than the $3\ P_{3/2}$ state. Further applications of the method are discussed.

2866 C.S. DeSilets, A.R. Selfridge, and G.S. Kino, "Highly Efficient Transducer Arrays Useful in Nondestructive Testing Applications."

Two types of highly efficient ransducer arrays are described which couple acoustic energy into the samples imaged in nondestructive testing applications. The first type of array utilizes fully slotted, double quarter-wave matched elements to couple the acoustic energy from the high impedance ceramic to water, which is used as the transmitting medium. One such 180 element linear array operating at a center frequency of 3.5 MHz has 11 dB return loss, 45% 3 dB bandwidth, and $\pm 13°$ 3 dB acceptance angle. Experimental results with an improved double quarter-wave matched, fully slotted array are described including 9 dB return loss, 65% 3 dB bandwidth, and $\pm 44°$ 3 dB acceptance angle.

A second type of high efficiency array uses unslotted ceramic permanently attached to a high impedance buffer block which is coupled directly to the load. Individual array elements are formed by deposition of electrodes on the monolithic slab of ceramic. One longitudinal wave test array mounted on aluminum is reported with a half power beamwidth of $\pm 37°$.

G.L. No.

2867 J.E. Bowers, B.T. Khuri-Yakub, G.S. Kino, and K-H Yu, "Design and Applications of High Efficiency Wideband SAW Edge Bonded Transducers."

Edge bonded transducers (EBTs) have the potential to be efficient and broadband SAW transducers for signal processing and nondestructive testing applications. A normal mode theory has been developed for the design of EBTs. EBTs have been made for SAW propagation on Quartz and Silicon Nitride ceramic, and the early results are in good agreement with theory.

2869 G. Herrmann and G.S. Kino, "Ultrasonic Measurements of Inhomogeneous Stress Fields."

An acoustic technique for measuring inhomogeneous stress fields in externally loaded solids is described. This method requires a measurement of transit time of a longitudinal acoustic wave through a stressed thin metal specimen using a small diameter water-coupled acoustic transducer. The transducer is mechanically scanned over the surface of the sample by a computer controlled system to take stress field contour plots. Samples investigated include an aluminum plate with a central hole, a double edge-notched panel and a single edge-notched panel. In addition to measuring stress fields, the non-destructive determination of stress intensity factors is also discussed.

IV. AUTHOR INDEX

(by G.L. Report Nos.)

Note: G.L. Reports Nos. 2651 to 2869 are listed in Section I and if they have abstracts (indicated by an asterisk) are listed in Section III also. G.L. Reports Nos. 2479, 2536, 2570, 2612, 2615, 2640, and 2650 (published in this period from manuscripts submitted prior to 1977) are listed in Section II.

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*Ph.D. Dissertation (Special Research Report)